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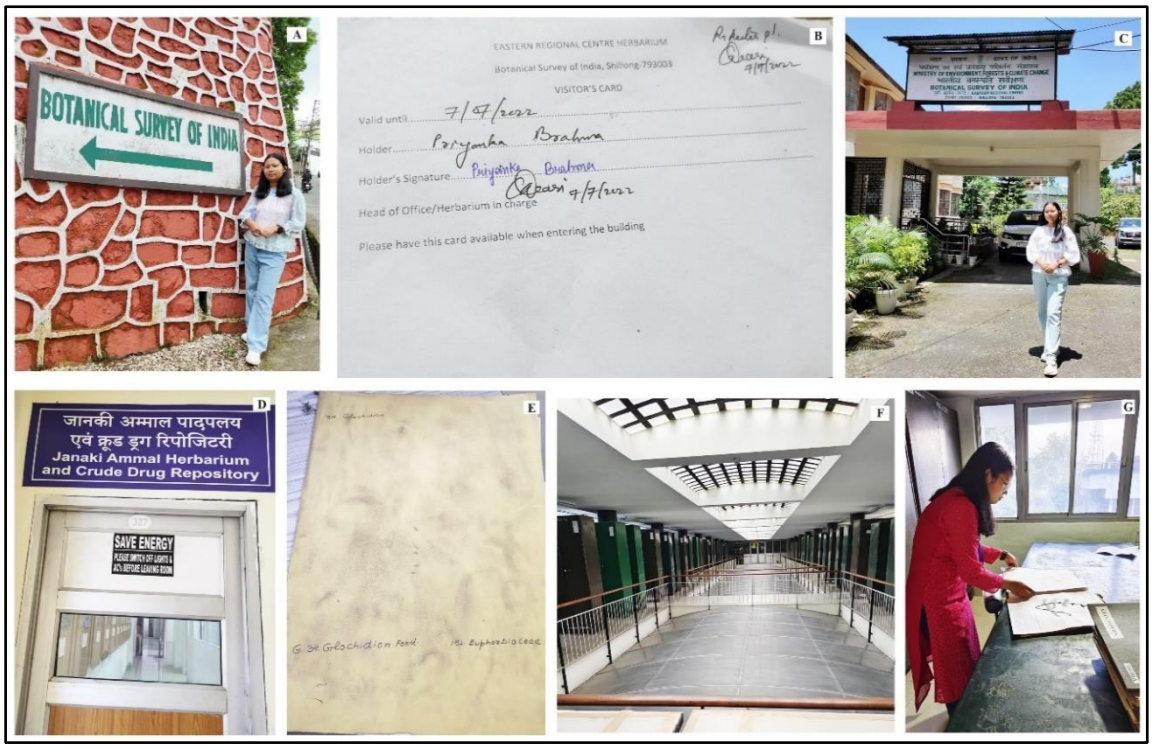

Plate 41. Type specimen study in different Herbaria **(A-C).** BSI, Shillong, Meghalaya, **(D-E).** CSIR IIIM, Jammu and **(F-G).** NBRI, Lucknow

Plate 42. (A-B). Landscape of Baokhungri Hill, Kokrajhar District, Assam

Plate 43. (A-B). Landscape of Ultapani Forest Range, Kokrajhar District, Assam

Plate 44. (A-B). Landscape of Chakrashila Wildlife Sanctuary, Kokrajhar District, Assam

Plate 45. (A-B). Landscape of Raimona National Park, Kokrajhar District, Assam

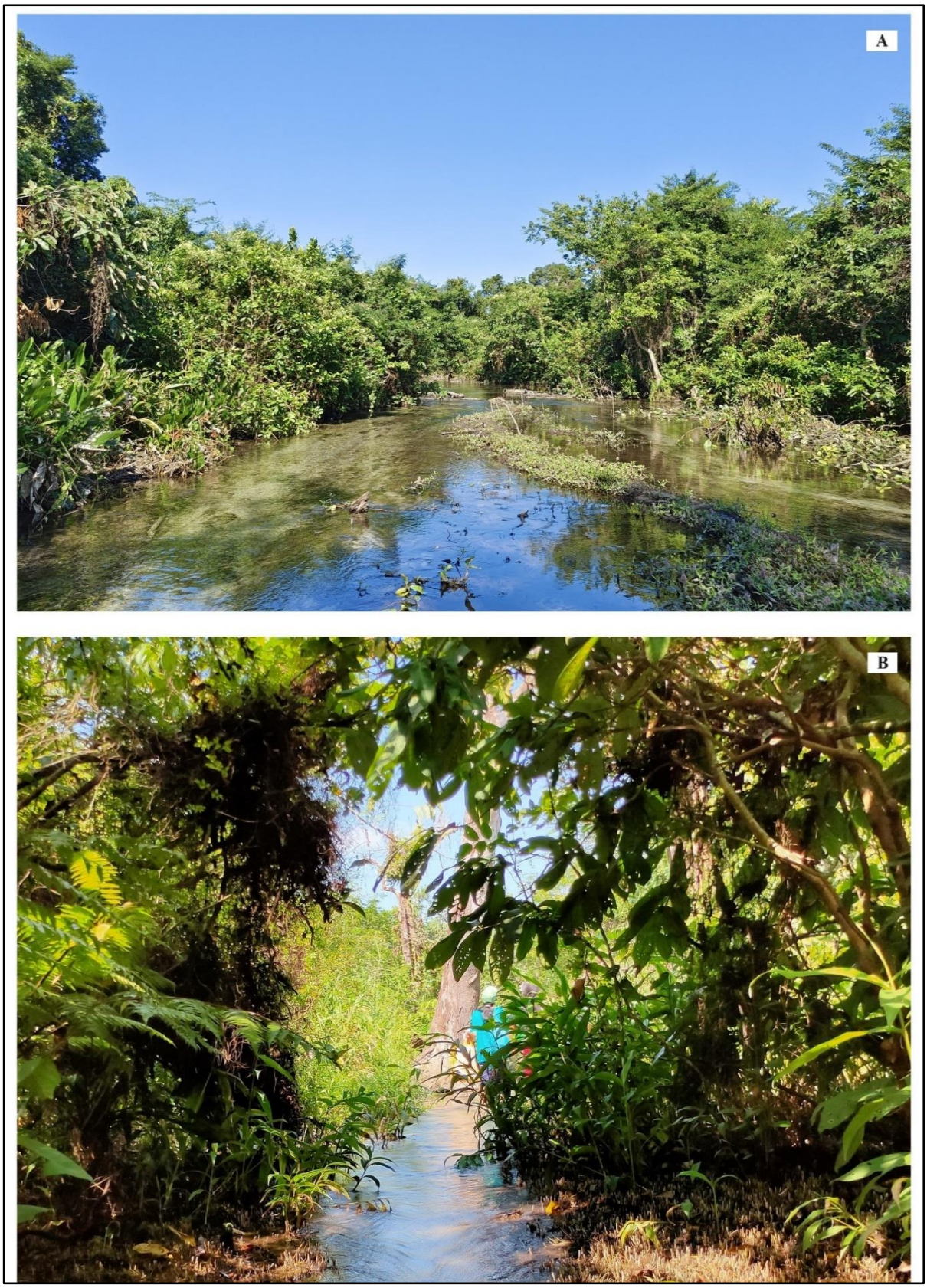

Plate 46. (A-B). Landscape of Owabari, Daolur Dwisa, Kokrajhar District, Assam

Plate 47. (A-C). Landscape of Manas National Park, Baksa District, Assam

Plate 48. (A-B). Landscape of Orang National Park, Udalguri District, Assam

Plate 49. (A-B). Landscape of Barnodi Wildlife Sanctuary, Udalguri District, Assam **(C-D).** Inside forest view of Nunai Reserve Forest, Udalguri District, Assam

Plate 50. (A-C). Landscape of Karbi Anglong District, Assam

Plate 51. (A-C). Landscape of Kaziranga National Park, Golaghat District, Assam

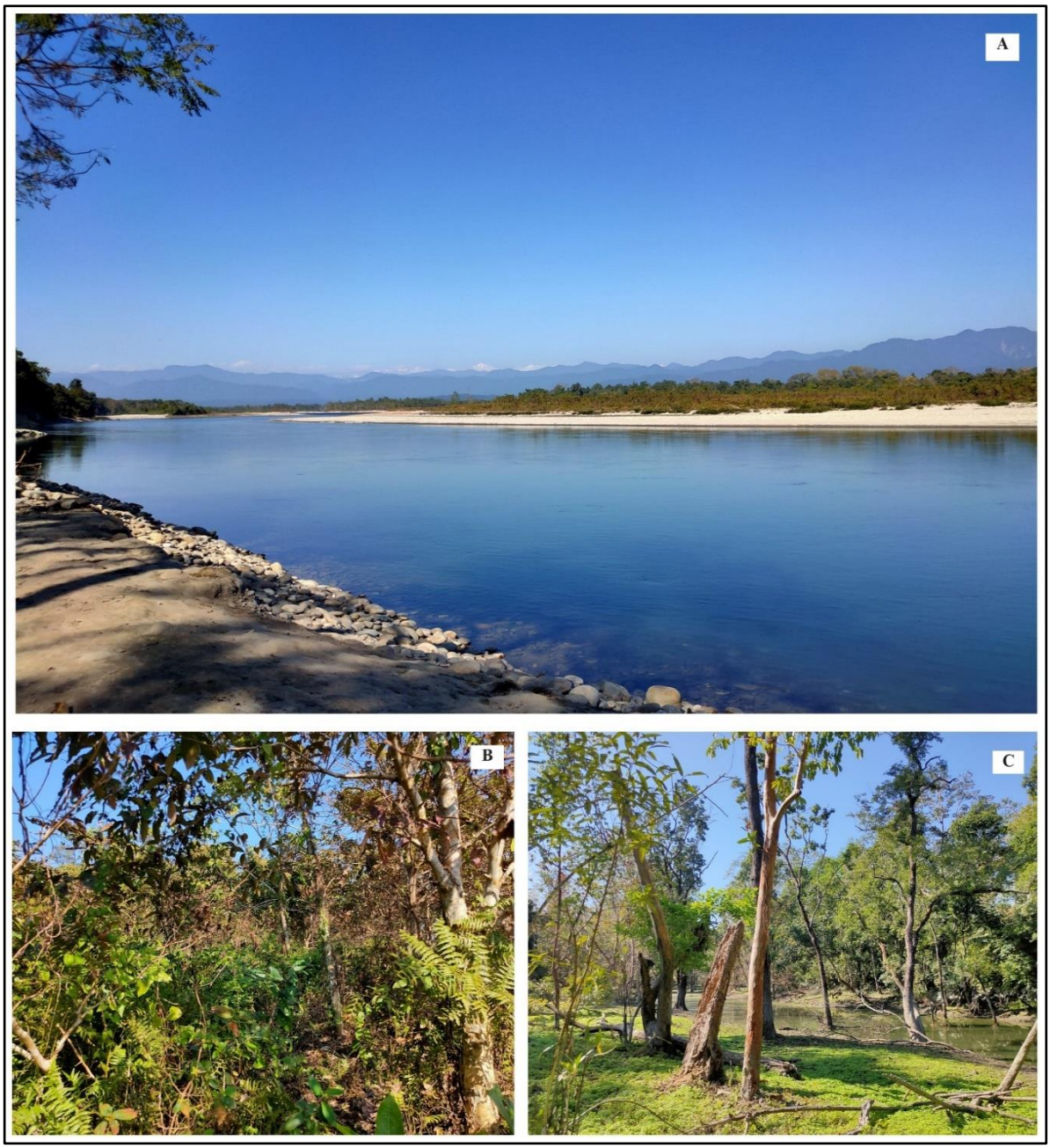

Plate 52. (A-C). Landscape of Nameri National Park, Balipara Reserve Forest, Sonitpur District, Assam

Plate 53. (A-B). Landscape of Cachar District, Assam **(C-D).** Dimahasao District, Assam

Plate 54. Different habitats of *Glochidion* spp. **A.** Grassland **B.** Moist shady area **C.** Hilly area **D.** Sal Forest **E.** Primary Forest **F.** Road side area **G.** Moist semi-evergreen forest **H.** Stream Side area

APPENDIX 1

PUBLICATIONS

1. **Brahma, P., & Baruah, S. (2023).** Investigation of phytochemical constituents, GC-MS, DPPH free radical scavenging assay, and mineral contents of *Glochidion sphaerogynum* (Mull. Arg.) Kurz bark extract. *Plant Science Today, 10*(2), 98–105. https://doi.org/10.14719/pst.2019 (**Figure 34**)
2. **Brahma, P., & Baruah, S. (2023).** Phytochemical analysis and determination of mineral elements in two species of genus *Glochidion* J.R. Forst. & G. Forst, pp. 43–60. In: P. S. Singh (ed.). *Traditional Medicinal Plants (Volume - 7)*. AkiNik publications. http://dx.doi.org/10.22271/ed.book.2290 (**Figure 35**)
3. **Brahma, P., & Baruah, S. (2023).** Extended distribution of an endemic variety *Glochidion zeylanicum* var. *paucicarpum* Chakrab. & N.P. Balakr. (Phyllanthaceae) from Assam, India. *Vegetos*. https://doi.org/10.1007/s42535-023-00650-0 (**Figure 36**)
4. **Brahma, P., & Baruah, S. (2023).** Comparative morphological and ethnobotanical assessment of certain taxa of genus *Glochidion* (Phyllanthaceae) from Assam, India. *Journal of Threatened Taxa*, *15*(12), 24409–24419. https://doi.org/10.11609/jot.8696.15.12.24409-24419 (**Figure 37**)
5. **Brahma, P., & Baruah, S. (2024).** Foliar epidermal micromorphology of genus *Glochidion* J.R.Forst. & G.Forst. (Phyllanthaceae) by using light and electron microscopy. *Current Botany*, *15*, 47–57. https://doi.org/10.25081/cb.2024.v15.8609 (**Figure 38**)

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RESEARCH ARTICLE

Investigation of phytochemical constituents, GC-MS, DPPH free radical scavenging assay, and mineral contents of *Glochidion sphaerogynum* (Mull. Arg.) Kurz bark extract

Priyanka Brahma & Sanjib Baruah*

Department of Botany, Bodoland University, Kokrajhar-783 370, Assam, India

*Email:sanjibbaruah9@gmail.com

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Abstract

The aim of the present study was to assess phytochemical constituents, chemical composition, DPPH free radical scavenging assay and mineral contents of *Glochidion sphaerogynum* (Mull.Arg.) Kurz bark extract. Standard procedures were used to test preliminary phytochemical constituents as well as quantitative analysis for total alkaloid, flavonoid, saponin, tannin, phenolic and terpenoid content. The extract was examined using gas chromatography-mass spectrometry (GC-MS) to know the biologically active compound. *In-vitro* antioxidant potential was investigated using DPPH free radical scavenging assay and the IC_{50} value for the antioxidant activity of bark extract was 37.4479 µg/mL. The qualitative phytochemical investigation revealed the presence of important phytochemical constituents as well as considerable amounts of total alkaloid, flavonoid, saponin, tannin, phenolic and terpenoid content. GC-MS revealed the presence of biologically active compounds like 1,1,6-Trimethyl-3-methylene-2-(3,6,10,13,14-pentamethyl-3-ethenyl-pentadec-4-enyl)cyclohexane; Benzenepropanoic acid, 3,5-bis(1,1-dimethyl ethyl) -4-hydroxy-, methyl ester; Neophytadiene etc which would be important for medicinal industries. Mineral contents were determined by using Atomic Absorption Spectrometry (AAS). The result revealed the presence of a good concentration of Na (10.552±0.343 ppm) and Ca (8.973±0.310 ppm) elements followed by K, Fe, Mg and Mn and very less concentrations of heavy metals such as Cd, Cr and Pb indicated the species was devoid of harmful metals.

Keywords

Glochidion sphaerogynum, phytochemical, GC-MS, DPPH, mineral contents

Introduction

The Plant produces many phytochemical constituents that protect them against insects, pathogens, and herbivores (1). Many of these phytochemical constituents also have different biological activities and protect human beings against various diseases (2, 3). According to WHO (World Health Organization), 80% of people rely on indigenous plant-based medicines for curing different diseases (4). Plant produces antioxidants as secondary metabolites, which are substances that act in the cell to counteract free radicals and reactive oxygen species (ROS) and control oxidative damage in the body that become scientifically compelling compounds as a consequence of many pharmacological activities (5, 6). One of the reliable analytical methods for identifying the different chemical components in a plant sample is gas chromatography-mass spectrometry (GC-MS) which plays a significant role in the analysis of phytochemical compounds (7-9).

Figure 34. Front page of a published paper

Chapter - 3

Phytochemical Analysis and Determination of Mineral Elements in Two Species of genus *Glochidion* J.R. Forst. & G. Forst.

Priyanka Brahma and Sanjib Baruah

Abstract

Glochidion multiloculare (Rottler ex. Willd.) Voigt and *G. ellipticum* Wight are two medicinally known species of the family Phyllanthaceae. Traditionally all the parts of the plants have been used by many tribes in India for medicinal purposes. Based on the traditional knowledge the current study was conducted to determine the presence of their phytoconstituents with their yield extract quantitatively as well as mineral components present in these two species. Phytochemical analysis has been carried out by following standard methods and the determination of mineral elements has been carried out by atomic absorption spectroscopy (AAS). The result of the phytochemical analysis showed the presence of important phytoconstituents as well as good extraction yield in both species. In both species, the highest concentration of calcium elements has been observed. It shows both plants have nutritional as well as medicinal value.

Keywords: *Glochidion multiloculare* (Rottler ex. Willd.) Voigt, *G. ellipticum* Wight, phytochemical, mineral

1. Introduction

Phytochemicals are chemical compounds that are found in the various parts of the plant and these phytoconstituents may be alkaloids, flavonoids, steroids, tannin, terpenoids, phenol, etc. and they possess various types of biological activities such as antioxidants, antimicrobial, antibacterial, cytotoxic activities, etc. These compounds play a major role in protecting plants and humans against harmful diseases [1]. Plants not only contain chemical compounds they are also known for their mineral composition which is beneficial for the daily needs of human beings. Essential elements play an important role in the human body but they can cause harmful disorders if the concentration of the elements is higher beyond the trace limits. The human

Figure 35. Front page of a published paper

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RESEARCH ARTICLES

Extended distribution of an endemic variety *Glochidion zeylanicum* var. *paucicarpum* Chakrab. & N.P. Balakr. (Phyllanthaceae) from Assam, India

Priyanka Brahma[1] · **Sanjib Baruah**[1]

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Abstract
Glochidion zeylanicum var. *paucicarpum* Chakrab. & N.P. Balakr., an endemic variety of family Phyllanthaceae, was recorded for the first time in Assam. The species was collected while working on the taxonomic study of the genus *Glochidion* in Assam. After a rational evaluation of published work on distribution, this variety was previously recorded only from Andaman and Nicobar Islands, Bay of Bengal, India and reported as an endemic variety under the species *G. zeylanicum* (Gaertn.) A.Juss. But the present study revealed that its occurrence in Kokrajhar district set extended distribution records for Assam including northeast India. The present communication deals with thorough taxonomic descriptions, phenology, habitat and ecology, distribution, threat status, and photographs, including a distribution map of the taxa for better taxonomic identity. Although the present study area recorded less population of the plant, the plant has been commonly used as medicine by the local community. Based on the threat status in the present work, the plant can be assigned to an endangered category. The present communication recorded an extended occurrence of the plant in Assam, so further population study of the plant in other regions of India is also needed.

Keywords *Glochidion* · Phyllantheae · New distribution · Endemic · Assam

Introduction

The genus *Glochidion* J.R.Forst. & G.Forst., belonging to the tribe Phyllantheae was one of the large genera of the family Phyllanthaceae with about 320 species and distributed mainly in tropical Asia to Northern Australia & Polynesia, with a few species in Madagascar and tropical America (Chakrabarty and Gangopadhyay 1995; Hoffmann et al. 2006; Chakrabarty and Balakrishnan 2018). In India, it comprises of 22 species and 13 varieties (Balakrishnan et al. 2012; Chakrabarty and Balakrishnan 2018). A total of 16 species of the genus were reported by Kanjilal et al. (1940) in "Flora of Assam" from the erstwhile Assam.

✉ Sanjib Baruah
sanjibbaruah9@gmail.com

Priyanka Brahma
priyabrahma659@gmail.com

[1] Department of Botany, Bodoland University, 783370 Kokrajhar, Assam, India

The name *Glochidion* was first given by J. R. Forster and G. Forster in 'Characteres Generum Plantarum' (1776) and the generic word "*Glochidion*" came from the Greek word "*Glochis*" which signifies the extension of anther connectives of a female flower (Chakrabarty and Gangopadhyay 1995). Members of *Glochidion* are found predominantly in grasslands, evergreen forests, *sal* forests, deciduous forests, subtropical forests, hilly places, swampy areas along stream sides, and roadside areas. They are generally shrub or large trees, drooping branched having either glabrous or hairy plant bodies, inflorescences exhibit axillary to supra-axillary with lobed and unlobed capsules. The genus comprises of many species and varieties and has been popularly known for its medicinal value in India (Chakrabarty and Balakrishnan 2018).

While exploring the field survey, a voucher specimen of the member *Glochidion* was collected. The present communication reported the presence of *Glochidion zeylanicum* var. *paucicarpum* Chakrab. & N.P. Balakr. in Assam for the first time. The specimen was distributed in Andaman and Nicobar Island, India and it was reported as an endemic

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Figure 36. Front page of a published paper

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COMMUNICATION

Comparative morphological and ethnobotanical assessment of certain taxa of genus *Glochidion* (Phyllanthaceae) from Assam, India

Priyanka Brahma [1] & Sanjib Baruah [2]

[1,2] Department of Botany, Bodoland University, Kokrajhar, Assam 783370, India.
[1] priyabrahma659@gmail.com (corresponding author), [2] sanjibbaruah9@gmail.com

Abstract: The genus *Glochidion*, a member of the family Phyllanthaceae, primarily comprises shrub or tree species. It stands out from other genera due to distinctive reproductive features, including prolonged styles in flowers and fruits, apiculate anthers, and lobed and unlobed capsules. This study aimed to compare the morphological characteristics of nine taxa in Assam to facilitate identification and assess ethnobotanical knowledge. Ethnobotanical information was gathered by interviewing the local community, and a taxonomic key was provided for accurate identification. Morphological data underwent principal component analysis (PCA) and cluster analysis using PAST for validation. The comparison revealed distinct characteristics in both vegetative and reproductive traits among *Glochidion* members. Reproductive features, such as inflorescence, style, ovary, and capsules, were key factors for differentiation and identification. PCA and cluster analysis demonstrated correlation and variation among the taxa, contributing significantly to their demarcation. Ethnobotanical studies indicated the genus's potential medicinal properties, supported by both primary and secondary information.

Keywords: Angiosperms, cluster analysis, ethnobotany, PCA, Phyllanthoideae, taxonomy, UPGMA.

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Author details: Dr. S. Baruah is working as an assistant professor at the Department of Botany, Bodoland University, Kokrajhar, Assam. SB has 15 years of research and teaching experience on the plant taxonomy and conservation of threatened plants in north-east India. Priyanka Brahma is a bona fide Ph.D. research scholar in the Department of Botany at Bodoland University. PB is pursuing her PhD on the taxonomy and phytochemistry of *Glochidion* in Assam.

Author contributions: PB has collected, done photography, identified, carried out the morphological analysis of the specimen, performed the PCA and cluster analysis and drafted the manuscript. SB contributed to the present study's design, supervised the work and revised the manuscript. The final manuscript was examined and approved by both the authors.

Acknowledgements: The authors are grateful to the Assam State Biodiversity Board (ASBB) and PCCF (Chief Wildlife Warden), Panjabari, Assam for granting permission to collect the specimen in protected areas of Assam. The authors are thankful to the authorities of BSI, Shillong, Meghalaya for providing the accession number of the deposited specimen. We also acknowledge the local villagers and traditional healers for sharing their knowledge on the collected specimens. The first author is thankful to the University Grants Commission for the National Fellowship and Scholarship for Higher Education of ST Students (NFST) scheme (Award No. 202021-NFST-ASS-01128) and the Government of India, Ministry of Tribal Affairs, Scholarship Division for financial assistance with her Ph.D.

Figure 37. Front page of a published paper

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Research Article

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Foliar epidermal micromorphology of genus *Glochidion* J.R.Forst. & G.Forst. (Phyllanthaceae) by using light and electron microscopy

Priyanka Brahma, Sanjib Baruah*

Department of Botany, Bodoland University, Kokrajhar-783370, Assam, India

ABSTRACT

The present study was conducted to compare both qualitative and quantitative characteristics of foliar epidermal micromorphology on some members of *Glochidion* in Assam. As taxonomic attributes, the foliar epidermal micromorphology study of nine taxa of both abaxial and adaxial surfaces was performed by using light microscopy (LM) and field emission scanning electron microscopy (FESEM). The result showed both amphistomatic and hypostomatic types of leaf surfaces. On the same surface of the leaf, multiple types of stomata were observed such as anomocytic, anisocytic, hemiparacytic, and paracytic types. Significant diversity and variations were observed in stomatal number, size, area, epidermal cell number, subsidiary cells, and trichomes. The stomatal index, stomatal shape, epidermal cell shape, length and width of the stomata, and trichomes showed variation among the studied taxa. Glands were absent in all studied members. Papillae and epicuticular wax crystals were observed in some taxa. In addition, a taxonomic key was also provided based on foliar leaf epidermal characteristics using qualitative and quantitative data from LM and FESEM. Based on quantitative data of foliar leaf micromorphology, principal component analysis (PCA) and cluster analysis were carried out to authenticate the micromorphological data. These would aid in the identification of taxa as well as in taxonomic delimitation.

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***Corresponding author:**
Sanjib Baruah
E-mail: sanjibbaruah9@gmail.com

KEYWORDS: *Glochidion*, Leaf epidermis, Light Microscopy, Field Emission Scanning Electron Microscopy, Principal Component Analysis, Trichome

INTRODUCTION

The genus *Glochidion* is a large member of the family Phyllanthaceae and the genus consists of c 320 species across the world and c 22 species and 8 varieties in India (Balakrishnan & Chakrabarty, 2007; Balakrishnan *et al.*, 2012; Chakrabarty & Balakrishnan, 2018). A total of 16 species from erstwhile Assam were described in "Flora of Assam" by Kanjilal *et al.* (1940). Earlier the genus was placed under the family Euphorbiaceae (Bentham & Hooker, 1862-1863; Hooker, 1890; Kanjilal *et al.*, 1940). According to Hoffmann *et al.* (2006), the genus was closely connected to the type of Phyllanthus as a result of the genus *Glochidion*, which includes *Breynia* J.R. & G.Forst., *Flueggea* Willd., and *Margaritaria* L.f., were classified under the family Phyllanthaceae and the tribe Phyllantheae. Additionally, a recent classification assigned the genus to the Phyllanthaceae family (The Angiosperm Phylogeny Group *et al.*, 2016). The biovulate ovary and lack of latex distinguish the family Phyllanthaceae from Euphorbiaceae (Chakrabarty & Balakrishnan, 2018).

The members of *Glochidion* are mainly shrubs or small trees and large trees. They can be found primarily along roadsides, in damp or humid deciduous areas, tropical, primary, and secondary forests, sal woods, mountainous terrain, and occasionally swampy places. The genus can be identified by its drooping branches, axillary and supra-axillary inflorescence, arrangement of male and female flowers, and lobed and unlobed capsules. Taxonomic studies of *Glochidion* based on morphological characters were conducted in many regions of the world (Robinson, 1909; Beille, 1927; Backer & van den Brink, 1963; Shaw, 1981; Li, 1994; Chakrabarty & Gangopadhyay, 1995; Nguyen, 2007; Li & Gilbert, 2008; Chakrabarty & Balakrishnan, 2018; Yao *et al.*, 2020). However, the micromorphological or leaf epidermal study is still lacking. Only a few species i.e., *G. hohenckari* and *G. neilgherrense* of the foliar epidermal study were covered by some workers (Thakur & Patil, 2011, 2014).

Micromorphological traits can often remain seen to be adequately varied to be used as a tool for taxonomy and species identification (Vislobokov *et al.*, 2021). The Epidermal features

Figure 38. Front page of a published paper

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RESEARCH ARTICLE

Investigation of phytochemical constituents, GC-MS, DPPH free radical scavenging assay, and mineral contents of *Glochidion sphaerogynum* (Mull. Arg.) Kurz bark extract

Priyanka Brahma & Sanjib Baruah*

Department of Botany, Bodoland University, Kokrajhar-783 370, Assam, India

*Email:sanjibbaruah9@gmail.com

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Abstract

The aim of the present study was to assess phytochemical constituents, chemical composition, DPPH free radical scavenging assay and mineral contents of *Glochidion sphaerogynum* (Mull.Arg.) Kurz bark extract. Standard procedures were used to test preliminary phytochemical constituents as well as quantitative analysis for total alkaloid, flavonoid, saponin, tannin, phenolic and terpenoid content. The extract was examined using gas chromatography-mass spectrometry (GC-MS) to know the biologically active compound. *In-vitro* antioxidant potential was investigated using DPPH free radical scavenging assay and the IC_{50} value for the antioxidant activity of bark extract was 37.4479 µg/mL. The qualitative phytochemical investigation revealed the presence of important phytochemical constituents as well as considerable amounts of total alkaloid, flavonoid, saponin, tannin, phenolic and terpenoid content. GC-MS revealed the presence of biologically active compounds like 1,1,6-Trimethyl-3-methylene-2-(3,6,10,13,14-pentamethyl-3-ethenyl-pentadec-4-enyl)cyclohexane; Benzenepropanoic acid, 3,5-bis(1,1-dimethyl ethyl) -4-hydroxy-, methyl ester; Neophytadiene etc which would be important for medicinal industries. Mineral contents were determined by using Atomic Absorption Spectrometry (AAS). The result revealed the presence of a good concentration of Na (10.552±0.343 ppm) and Ca (8.973±0.310 ppm) elements followed by K, Fe, Mg and Mn and very less concentrations of heavy metals such as Cd, Cr and Pb indicated the species was devoid of harmful metals.

Keywords

Glochidion sphaerogynum, phytochemical, GC-MS, DPPH, mineral contents

Introduction

The Plant produces many phytochemical constituents that protect them against insects, pathogens, and herbivores (1). Many of these phytochemical constituents also have different biological activities and protect human beings against various diseases (2, 3). According to WHO (World Health Organization), 80% of people rely on indigenous plant-based medicines for curing different diseases (4). Plant produces antioxidants as secondary metabolites, which are substances that act in the cell to counteract free radicals and reactive oxygen species (ROS) and control oxidative damage in the body that become scientifically compelling compounds as a consequence of many pharmacological activities (5, 6). One of the reliable analytical methods for identifying the different chemical components in a plant sample is gas chromatography-mass spectrometry (GC-MS) which plays a significant role in the analysis of phytochemical compounds (7-9).

Glochidion sphaerogynum is a small tree belonging to the genus *Glochidion* of the family Phyllanthaceae which mainly grows in primary evergreen forests, secondary forests, hilly, or roadside areas, distributed in Bhutan, Nepal, Bangladesh, Myanmar, China, Vietnam, Thailand and states of India (10). This species can be identified by its glabrous plant body, long acuminate leaves, axillary inflorescence and distinguishable lobed capsules from other members of the genus *Glochidion*. The genus *Glochidion* contains various chemical constituents that include flavonoid, terpenoid, glycoside, steroid, phenolic compounds, triterpenoid, tannin, saponin, alkaloid, resin, anthraquinone, reducing sugar, phlobatannin and carbohydrate (11). This proves the importance of the genus as a source of medicinal value. The leaves and branches of *G. sphaerogynum* have been used mainly for the treatment of influenza, skin problems, common cold, fever, ulcers and inflammation in some countries (12-14). However, no detailed examination of the phytochemical composition, GC-MS analysis, antioxidant potential and assessment of mineral contents of this plant has been published so far. So, the present study desired to evaluate phytochemical analysis, identification of biologically active compounds using GC-MS, antioxidant potential using DPPH free radical scavenging assay and assessment of mineral contents in the bark extract of *G. sphaerogynum* based on their medicinal importance. Hence, the present study was also conducted to know the biologically active components, their mineral composition and the antioxidant capacity present in the bark extract.

Materials and Methods

Collection and identification of the plant material

The field survey was conducted from January to April 2021 and fresh plant specimens were collected in the Kokrajhar district of Assam. The plant material was identified following the literature i.e., Flora of Assam and a voucher specimen (008 BUBH) was deposited in the Bodoland University Botanical Herbarium (BUBH), Kokrajhar, Assam (15, 16).

Preparation of the plant extracts

After identification of the specimen fresh bark material was collected. The collected bark was properly washed with distilled water and dried in the shade for one and half months until it becomes completely moisture free. After drying, it was ground to a coarse powder and kept in an airtight container. Twenty gms of the powdered sample was taken and soaked in 200 mL of methanol for 72 hrs and filtered through Whatman filter paper no. 1. Then the filtrate extract was evaporated with a vacuum rotary evaporator (Ikon instruments) and set the temperature according to the boiling point of the solvent. After evaporation residue was taken and stored at 4 °C for future analysis of the sample (17, 18).

Phytochemical screening

Alkaloid, reducing sugar, steroid, phlobatannin, tannin, flavonoid, terpenoid, triterpenoid, saponin, glycoside and phenol were tested according to standard methods (18-21).

Quantitative estimation of phytochemical constituents

Total alkaloid content

2.50 g of powder bark sample was measured, and 200 mL of 10% acetic acid (CH_3COOH) in ethanol (C_2H_5OH) was added, followed by 4 hrs of rest. The filtrate was then heated in a water bath after filtration. Until the precipitation was complete, concentrated ammonium hydroxide (NH_4OH) was applied. It was then washed with 20 mL of 0.1M ammonium hydroxide (NH_4OH) and filtered using Whatman filter paper no. 1. The residue was dried in an oven before being weighed on an electronic balance. The total alkaloid content can be calculated using the following formula-

Alkaloid (%) = Final weight of the residue/Initial weight of sample ×100 (18, 19).

Total flavonoid content

2.50 g of powder bark sample was mixed with 50 mL of 80% aqueous methanol (CH_3OH) in a 250 mL beaker, it was covered and kept at 20 °C for 24 hrs. The supernatant was discarded, and the residue was extracted 3 times more, each time with the same volume of ethanol (C_2H_5OH). Then, using Whatman filter paper no. 1, the entire solution was filtered. The filtrate was dried and weighed in an electronic balance after being evaporated over a water bath. Total flavonoid content can be done as-

Flavonoid (%) = Final weight of the residue/Initial weight of sample ×100 (18, 19).

Total saponin content

5 g of powdered bark material was put into a 250 mL conical flask, followed by 100 mL of 20% aqueous ethanol (C_2H_5OH), and heated in a hot water bath for 4 hrs at 55 °C. The procedure was carried out twice more. The mixed extract was then reduced to 40 mL in a water bath at 90 °C. The mixed extract was placed in a separating funnel and rapidly shaken with 20 mL diethyl ether {$(C_2H_5)_2O$}. The ether layer was then removed. The purifying process was repeated 2 times. After that, 60 mL of n-butanol ($C_4H_{10}O$) was added, followed by 2 times washing with 10 mL of 5% sodium chloride (NaCl). To obtain a final concentration of saponin, the sodium chloride layer was removed and the residual solution was heated in a water bath and dried at 50 °C in an oven. Total saponin content can be done as-

Saponin (%) = Final weight of the residue/Initial weight of sample ×100 (18, 19).

Total phenolic content

The total phenolic content of the methanolic bark extract was determined following the Folin Ciocalteu's (FC) method using UV-Vis Spectrophotometer (Shimadzu A 125358) with slight modification (22, 23). 0.01 g sample was weighed and made up to 1800 µL of distilled water. Then 150 µL of Folin Ciocalteu reagent and 1 mL of 10% sodium carbonate (Na_2CO_3) were added and made up to 3 mL of volume and incubated in the absence of light for 40 min. Absorbance was measured at 765 nm against a blank and the calibration curve was created using the standard gallic acid in the range of 10-50 µg/mL. Based on the average of three experiments, the phenolic content of bark extract

was quantified as mg of gallic acid equivalents of dried extract (mg GAE/g dry extract).

Total tannin content

The tannin content of the bark extract was quantified using the Folin Denis (FD) method in UV-Vis Spectrophotometer (Shimadzu A 125358) with slight modification (24-27). 0.01 g of the sample was weighed and made up of 1800 µL of distilled water. After that, 150 mL FD reagent and 1 mL sodium carbonate (Na_2CO_3) were added to make a total volume of 3 mL, which was then incubated in the absence of light for 40 min. The calibration curve was built using tannic acid as a standard (10-50 g/mL) and calculated at the absorbance of 760 nm versus a blank. Based on the average of 3 experiments the total tannin content was quantified as mg of tannic acid equivalents of dried extract (mg TAE/g dry extract).

Total Terpenoid content

Total terpenoid content was determined as described by the given method (28, 29). For 24 hrs, 2 g of the material was dissolved with 50 ml of ethanol (C_2H_5OH). The mixture was then filtered using Whatman No. 1 filter paper. The filtrate was collected and extracted with petroleum ether (C_6H_{14}) before being dried at 65 °C in a water bath. Then the residue was collected and calculated the final volume. Total terpenoid content can be determined as-

$$\text{Terpenoid (\%)} = \frac{\text{Final weight of residue}}{\text{Initial weight of sample}} \times 100$$

GC-MS Analysis

GC-MS analysis of *G. sphaerogynum* (Mull.Arg.) Kurz bark extract was performed with a Perkin Elmer (USA) Clarus 680 GC and amp. Turbo Mass Ver. 6.1.2 instrument. The system was programmed using the software, and the peaks were examined with the NIST-2014 software. The stationary phase was 5% diphenyl 95% dimethyl polysiloxane, while the carrier gas was helium gas (99.99 %) at a flow rate of 1mL/min. A 2 µL injection volume was used in splitless mode. The injector has a temperature of 280 °C, whereas the ion source has a temperature of 180 °C. Electron Impact positive (EI+) mode was used to obtain Mass Spectra at 70 eV. The mass spectrum of peaks and compounds was determined using NIST-2014 software and a library search (30).

DPPH free radical scavenging assay

The antioxidant activity of a methanolic extract of *G. sphaerogynum* bark was tested using the 2,2-Diphenyl-1-picryl-hydrazyl-hydrate (DPPH) assay with slight modification (31-34). In the absence of light, 1 mL methanolic extract solutions (10-60 µg/mL) were dissolved in 3 mL DPPH solution and incubated. 3 mL methanol was used to make the blank, and 2 mL methanol and 1 mL DPPH solution were used to make the control. With a UV-Vis spectrophotometer, the absorbance of extracts was measured at 517 nm after 30 min and compared to that of normal ascorbic acid at equal amounts. The ability of the DPPH radical scavenging assay was calculated using the following formula-

% of inhibition = (Absorbance of control - Absorbance of the sample extract or standard)/Absorbance of control × 100

The IC_{50} value was obtained using linear regression analysis. If the IC_{50} value is lower, the antioxidant activity is stronger.

Assessment of mineral contents

Atomic Absorption Spectrometry (AAS), Model: Shimadzu AA-7000, was used to determine Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe), Manganese (Mn), Cadmium (Cd), Chromium (Cr) and Lead (Pb) at CIF IASST, Guwahati, Assam. The material was digested with concentrated nitric acid (HNO_3) and hydrogen peroxide (H_2O_2) using the wet ashing process. 0.50 g of sample was mixed with 8 mL of HNO_3 and let to stand overnight. The following day, it was heated for 1 hr at 120 °C on a hot plate with 4 mL H_2O_2 until the digestion was colorless. At 80 °C, the residue was dried and diluted with hydrochloric acid (HCl) and filtered. The results of the AAS were determined as ppm concentration based on the average of 3 readings in AAS (35).

Statistical Analysis

All the tests were done in 3 replicates. The data was determined as an average of 3 experiments (n=3) and calculated mean ± standard deviation (SD) using Microsoft Excel. The statistical analysis was performed by ANOVA single factor at $p \leq 0.05$ level in Microsoft Excel.

Results

Phytochemical screening

The presence of significant secondary metabolites such as alkaloid, steroid, phlobatannin, tannin, flavonoid, terpenoid, triterpenoid, saponin, glycoside and phenol was confirmed in the methanolic bark extract of *G. sphaerogynum* (Table 1).

Table 1. Preliminary phytochemical screening of methanolic bark extract of *G. sphaerogynum*

Phytochemical constituents	Test/Reagent	Result
Alkaloid	Dragendorff's reagent	+
	Mayer's reagent	+
	Wagner's reagent	+
Reducing sugar	Fehling's test	-
Steroid	Salkowski test	+
Phlobatannin	HCl test	+
Tannin	$FeCl_3$ test	+
Flavonoid	$FeCl_3$ test	+
	H_2SO_4 test	-
Terpenoid	Salkowski test	+
Triterpenoid	H_2SO_4 test	+
Saponin	Foam test	+
Glycoside	Keller-Killiani test	-
	Borntrager's test	+
Phenol	$FeCl_3$ test	+

Positive sign (+) = Present; Negative sign (-) = Absent.

Quantitative estimation of phytochemical constituents

According to the result of quantitative phytochemical analysis, total alkaloid and flavonoid contents obtained 3.73% (0.093±0.025) and 1.24% (0.031±0.019) yield respectively. The total saponin content exhibited a 12.94% (0.646±0.473) yield. Total tannin and phenolic contents were 6.92112 mg TAE/g dry extract (0.744±0.062) and 0.1666 mg GAE/g dry extract (0.328±0.045) respectively. The total terpenoid content obtained was 8.66% (0.173±0.066) yield (Table 2).

Table 2. The total alkaloid, flavonoid, saponin, phenolic, tannin and terpenoid contents in methanolic bark extract of *G. sphaerogynum*

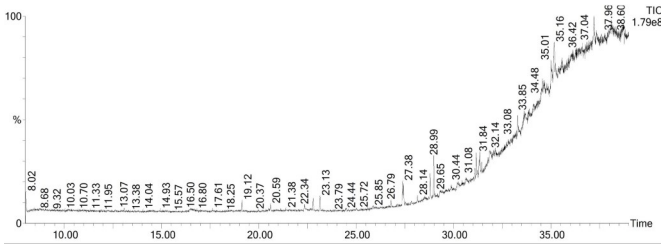
Parameters	Result
Total alkaloid content (% yield)	0.093±0.025
Total flavonoid content (% yield)	0.031±0.019
Total saponin content (% yield)	0.646±0.473
Total phenolic content (mg GAE/g)	0.328±0.045
Total tannin content (mg TAE/g)	0.744±0.062
Total terpenoid content (% yield)	0.173±0.066

Sample was analyzed in three replicates and data were indicated as an average of three tests (n=3), mean ± standard deviation (SD), and they were significantly different from each other at $p \leq 0.05$ level (ANOVA single test).

GC-MS Analysis

The bioactive compounds present in methanolic bark extracts of the *G. sphaerogynum* were shown in Fig. 1. The retention time, molecular weight, molecular formula and % of peak area were identified using the NIST library and presented in Table 3. The important bioactive compound present in the methanolic bark extract were Hentriacontane, Xanthosine, Fluorene, Phenanthrene, Neophytadiene, Benzenepropanoic acid,3,5-bis(1,1-dimethyl ethyl)-4-hydroxy-,methyl ester, 2,6,10,14-Tetramethyl-7-(3-methylpent-4-enylidene)pentadecane, Z,Z-6,28-Heptatriactontadien-2-one, 1,1,6-Trimethyl-3-methylene-2-(3,6,10,13,14-pentamethyl-3-ethenyl-pentadec-4-enyl)cyclohexane, Methyl 2-hydroxy-eicosanoate.

Fig. 1. GC-MS chromatogram of methanolic bark extract of *G. sphaerogynum*



DPPH free radical scavenging assay

The antioxidant potential of bark extract was evaluated using the DPPH assay. DPPH free radical scavenging assay of concentrations (10-60 µg/mL) and percentage inhibition of bark extract and the standard ascorbic acid were presented in Table 4. Radical scavenging assay at the concentration of 60 µg/mL, bark extract and ascorbic acid showed inhibition of 58.503±0.095% and 71.055±0.064% respectively. The IC_{50} value of bark extract and standard ascorbic acid were 37.4479 µg/mL and 20.9167 µg/mL respectively that indicating a good amount of antioxidant potential.

Assessment of mineral contents

The result of the mineral analysis of *G. sphaerogynum* bark extract was enlisted (Table 5). The result showed that sodium (Na) had the highest mineral contents of 10.552±0.343 ppm followed by calcium (Ca) and potassium (K) contents of 8.972±0.310 ppm and 7.230±0.086 ppm respectively. Sodium, calcium and potassium are one of the most important minerals in the body. K and Na help to maintain ionic balance, which helps to prevent hypertension and improve blood pressure (36, 37). Ca helps to maintain teeth, bone, blood clotting and muscle to contract and regulate normal heart rhythms and nerve function (38).

Discussion

The results of preliminary qualitative phytochemical screening of the methanolic extract of *G. sphaerogynum* bark showed the presence of important phytochemical constituents such as alkaloid, flavonoid, steroid, phlobatannin, tannin, terpenoid, triterpenoid, saponin, glycoside and phenol that would be implied on the identification of new sources of plants as pharmaceutical applications. The quantitative phytochemical estimation revealed a high % yield of saponin content (12.94%) followed by terpenoid content (8.66%) and a good concentration of tannin content of 6.92112 mg TAE/g dry extract (0.744±0.062) and phenolic content of 0.1666 mg GAE/g dry extract (0.328±0.045) respectively. In the present study, a good amount of alkaloids and flavonoids also have been recorded. Important biological activities such as antioxidant, anti-inflammatory, antibacterial and antimicrobial activities are known to exist in terpenoids, phenols, flavonoids, saponins, tannins and alkaloids (39).

The molecule 1,1,6-Trimethyl-3-methylene-2-(3,6,10,13,14-pentamethyl-3-ethenyl-pentamethyl-3-ethenyl-pentadec-4-enyl) cyclohexane which is the primary compound identified as having pharmacological activities such as antimicrobial, anti-inflammatory, anticancer, antiarthritic, antiviral with the highest peak area of 2.263% followed by the compound Benzenepropanoic acid, 3,5-bis (1,1-dimethyl ethyl)-4-hydroxy-, methyl ester with the peak area of 1.091% that has antioxidant and antifungal properties found during the GC-MS analysis. From the GC-MS data, all the identified compounds possess important biologically active compounds such as antioxidants, antitumor, antimicrobial, anti-inflammatory, antifungal, cytotoxic and various pharmacological activities which creates a basis for defining the plant's potential benefits in medicinal industries (Table 3).

The DPPH free radical scavenging assay was used to examine antioxidant activity. The result showed that the concentrations of methanolic bark extracts had significant DPPH free radical scavenging effects. The highest % inhibition (59.512±0.557) showed in 50 µg/mL followed by 58.503±0.095 % inhibition in 60 µg/mL with a potent antioxidant amount of IC_{50} value. Further assays are required to know the significance of the antioxidant capacities of the extract.

Table 3. Identified chemical composition of methanolic bark extract of *G. sphaerogynum* using GC-MS and their biological activity

Sl. No.	Retention time	Compound name	Peak area %	Molecular weight	Molecular formula	Biological activity
1	19.123	Hentriacontane	0.249	436	$C_{31}H_{64}$	Anti-inflammatory, antitumor and antimicrobial activities (44)
2	20.588	Xanthosine	0.247	284	$C_{10}H_{12}N_4O_6$	Therapeutic and pharmacological property (45)
3	23.139	Fluorene	0.473	166	$C_{13}H_{10}$	Drug design (46)
4	27.381	Phenanthrene	0.608	178	$C_{14}H_{10}$	Analgesic, antitussive, antimalarial, cytotoxic, anti-constipation, antioxidant, anti-inflammatory activity (47)
5	28.141	Neophytadiene	0.229	530	$C_{20}H_{38}$	Anti-inflammatory, antipyretic, analgesic, antioxidant, antimicrobial, antifungal, antibacterial activity (48-52)
6	28.987	Benzenepropanoic acid, 3,5-bis (1,1-dimethyl ethyl)-4-hydroxy-, methyl ester	1.091	292	$C_{18}H_{28}O_3$	Antioxidant, antifungal (53-56)
7	31.848	2,6,10,14-Tetramethyl-7-(3-methylpent-4-enylidene) pentadecane	0.468	348	$C_{25}H_{48}$	Anti-inflammatory, Antioxidant (57)
8	33.849	Z,Z-6,28-Heptatriactontadien-2-one	0.751	530	$C_{37}H_{70}O$	Vasodilatory, carcinogenic, antioxidant activity (58, 59)
9	35.174	1,1,6-Trimethyl-3-methylene-2-(3,6,10,13,14-pentamethyl-3-ethenyl-pentadec-4-enyl) cyclohexane	2.263	442	$C_{32}H_{58}$	Pharmacological activity, antimicrobial, anticancer, antiarthritic, anti-inflammatory and antiviral properties (60, 61)
10	37.955	Methyl 2-hydroxy-eicosanoate	0.275	342	$C_{21}H_{42}O_3$	Pharmaceutical property, antioxidant, anti-inflammatory (62, 63)

Table 4. DPPH assay of methanolic bark extract of *G. sphaerogynum*

Concentration (µg/mL)	% inhibition	
	Bark extract	Ascorbic acid
10	38.272±1.165	41.767±0.641
20	44.080±0.586	59.143±0.109
30	42.013±1.190	56.091±0.461
40	51.070±0.794	62.072±0.346
50	59.512±0.557	65.985±0.031
60	58.503±0.095	71.055±0.064
IC_{50}(µg/mL)	37.4479	20.9167

The sample was analyzed in three replicates and data were indicated as an average of three tests (n=3), mean ± standard deviation (SD) and they were significantly different from each other at $p \leq 0.05$ level (ANOVA single test)

Table 5. Mineral assessment of bark of *G. sphaerogynum*

Minerals	Result (ppm)
Sodium (Na)	10.552±0.343
Potassium (K)	7.230±0.086
Calcium (Ca)	8.973±0.310
Magnesium (Mg)	3.379±0.167
Iron (Fe)	4.026±0.076
Manganese (Mn)	3.367±0.179
Chromium (Cr)	0.162±0.011
Lead (Pb)	0.162±0.016
Cadmium (Cd)	0.009±0.002

The sample was analyzed in three replicates and data were indicated as an average of three tests (n=3), mean ± standard deviation (SD), and they were significantly different from each other at $p \leq 0.05$ level (ANOVA single test)

In order to be healthy, the human body requires a variety of minerals found in different varieties of plants. Apart from this, plants possess minerals that are beneficial for humans and some toxic metals which are harmful to human health. The presence of heavy metal toxicity in plants may create severe problems. The determination of mineral composition showed the highest concentration in sodium (Na) elements followed by calcium (Ca), potassium (K), iron (Fe), magnesium (Mg), manganese (Mn), and less concentration of chromium (Cr), lead (Pb) and cadmium (Cd). Na maintains the osmotic pressure in the body and activates nerves and muscle functions (40). K and Na maintain the ionic equilibrium that helps to prevent hypertension and enhances blood pressure (36, 37). Mg is important for enzyme activation and bone formation and Ca plays an important role as a constituent of bones and teeth formations, regulation of nerves and muscles functions in living cells and helps in membrane formulating (40). Fe is linked to haemoglobin and oxygen transmission from the lungs to tissue cells. Mn activates enzymes and is involved in urea formation, haemoglobin formation, helping in the nervous system and normal bone growth (37, 41, 42). Cd, Pb and Cr are non-essential elements in both plants and humans if it consists of high concentration. They are responsible for toxic substances (43). Plants are a good source of phytochemicals and minerals that can be useful for the nutraceutical industry. Several investigations have found elemental content in plant extracts that we consume as herbal health supplements or medicine and biochemical processes in the human body are affected by macro and trace elements (36, 37, 41). Therefore, it was evident from the results that the plants would be free of harmful materials because of the very low concentration of Cr, Pb, and Cd and could be important mineral consuming plants due to the presence of the important mineral elements.

Conclusion

The study revealed that plant has a potential source of phytochemical constituents that would be beneficial to humankind. The GC-MS analysis justifies the presence of important biological and pharmacological properties such as antifungal, antibacterial, antioxidant, antimicrobial, anti-inflammatory, antimalarial, analgesic and cytotoxic activities). This study can serve as a basis for additional research on the biological activities of the plant. The DPPH assay of bark extract exhibited a good amount of antioxidant compound which could be useful in the pharmaceutical and medicinal industry. Mineral determination indicated the presence of a significant number of mineral factors such as sodium (Na), calcium (Ca), potassium (K), iron (Fe), magnesium (Mg), manganese (Mn) and the plant could be free from toxic substances due to less concentration of heavy metal such as Cadmium (Cd), Chromium (Cr) and Lead (Pb). This is the first report citing mineral contents and detailed phytochemical evaluation, GC-MS and antioxidant analysis of the *G. sphaerogynum*. Further studies are needed to isolate biologically active compounds as important in pharmacological industries.

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Authors contributions

PB collected and identified the specimen, analyzed the data, performed the statistical analysis and drafted the manuscript. SB participated in the design of the study, supervised the work and revised the manuscript. Both authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None.

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Cover: The critically endangered *Lilium polyphyllum* in watercolour and acrylics. © Aishwarya S Kumar.

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Comparative morphological and ethnobotanical assessment of certain taxa of genus *Glochidion* (Phyllanthaceae) from Assam, India

Priyanka Brahma [1] & **Sanjib Baruah** [2]

[1,2] Department of Botany, Bodoland University, Kokrajhar, Assam 783370, India.
[1] priyabrahma659@gmail.com (corresponding author), [2] sanjibbaruah9@gmail.com

Abstract: The genus *Glochidion*, a member of the family Phyllanthaceae, primarily comprises shrub or tree species. It stands out from other genera due to distinctive reproductive features, including prolonged styles in flowers and fruits, apiculate anthers, and lobed and unlobed capsules. This study aimed to compare the morphological characteristics of nine taxa in Assam to facilitate identification and assess ethnobotanical knowledge. Ethnobotanical information was gathered by interviewing the local community, and a taxonomic key was provided for accurate identification. Morphological data underwent principal component analysis (PCA) and cluster analysis using PAST for validation. The comparison revealed distinct characteristics in both vegetative and reproductive traits among *Glochidion* members. Reproductive features, such as inflorescence, style, ovary, and capsules, were key factors for differentiation and identification. PCA and cluster analysis demonstrated correlation and variation among the taxa, contributing significantly to their demarcation. Ethnobotanical studies indicated the genus's potential medicinal properties, supported by both primary and secondary information.

Keywords: Angiosperms, cluster analysis, ethnobotany, PCA, Phyllanthoideae, taxonomy, UPGMA.

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Author details: Dr. S. Baruah is working as an assistant professor at the Department of Botany, Bodoland University, Kokrajhar, Assam. SB has 15 years of research and teaching experience on the plant taxonomy and conservation of threatened plants in north-east India. Priyanka Brahma is a bona fide Ph.D. research scholar in the Department of Botany at Bodoland University. PB is pursuing her PhD on the taxonomy and phytochemistry of *Glochidion* in Assam.

Author contributions: PB has collected, done photography, identified, carried out the morphological analysis of the specimen, performed the PCA and cluster analysis and drafted the manuscript. SB contributed to the present study's design, supervised the work and revised the manuscript. The final manuscript was examined and approved by both the authors.

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INTRODUCTION

Northeastern India, including Assam, has a wide variety of vegetation due to its topographic and climatic diversity. It is one of the most diverse regions in the world (Dutta & Dutta 2005; Mao & Roy 2016; Bhattacharyya et al. 2020). The people of Assam have employed a number of plants to treat a wide range of ailments since ancient times (Kanjilal et al. 1940; Bhattacharya et al. 1991). There are many medicinal plants in the area that are well-known to ethnic communities, and Assam is regarded as one of the ecological hot spots in the world (Myers et al. 2000; Asati & Yadav 2004; Saikia et al. 2006).

The species of *Glochidion* J.R.Forst. & G.Forst. have been used by local people in different places in the world and have immense value in the field of medicine (Lai et al. 2004; Xiao et al. 2008; Bajpai et al. 2016; Chakrabarty & Balakrishnan 2018). Some important biological and pharmacological activities, including the anticancer, antioxidant, and antimicrobial activities of a few members of *Glochidion* have been reported by many workers (Azam et al. 2012; Rathod & Rajurkar 2017). The people of India mainly rely on medicinal plants and are well-known for ethnobotanical knowledge (Maikhuri & Gangwar 1993; Prakash et al. 2008). Therefore, it was felt worth exploring the genus *Glochidion* in Assam for its current taxonomy and to assess its ethnomedicinal uses.

The genus *Glochidion* J.R.Forst. & G.Forst. is a member of the family Phyllanthaceae which is native to northern Australia, Polynesia, southern Asia, and tropical Asia (Chakrabarty & Balakrishnan 2018). The members of the genus are either shrubs or trees, monoecious, pubescent, or glabrous with drooping branches. They are mostly found in evergreen, moist deciduous, tropical, primary and secondary forests, sal forests, hilly areas, and some swampy areas. There are over 320 species worldwide; about 22 species, and eight varieties in India (Balakrishnan & Chakrabarty 2007; Balakrishnan et al. 2012; Chakrabarty & Balakrishnan 2018; Brahma & Baruah 2023). Kanjilal et al. (1940) designated 16 species from erstwhile Assam in 'Flora of Assam'. At present 12 species and four varieties of the genus are found in Assam (Chakrabarty & Balakrishnan 2018). Traditionally, *Glochidion* was placed in Euphorbiaceae (Bentham & Hooker 1862–1883; Hutchinson 1973). Later, Hoffmann et al. (2006) discovered that the genus *Glochidion* sensu lato includes *Breynia* J.R.Frost & G.Forst., *Flueggea* Willd. and *Margaritaria* L.f., which are all allied to *Phyllanthus* as members of the tribe Phyllantheae and, therefore, belong to the segregate family Phyllanthaceae, and this was later ascertained by Chase et al. (2016) on the molecular basis. The absence of latex and the bi-ovulate ovary distinguish the family Phyllanthaceae from Euphorbiaceae (Chakrabarty & Balakrishnan 2018).

Earlier in some floras, *G. ellipticum* used to be referred to as *G. assamicum*, a synonym of *G. ellipticum*; *G. velutinum*, i.e., synonym of *G. heyneanum*; *G. hirsutum* or *G. tomentosum*, i.e., synonym of *G. zeylanicum* var. *tomentosum;* and *G. arborescens*, i.e., synonym of *G. zeylanicum* var. *arborescens* (Hooker 1890; Kanjilal et al. 1940). According to recent literature and taxonomy data, the taxa *G. ellipticum*, *G. heyneanum*, *G. zeylanicum* var. *tomentosum*, *G. zeylanicum* var. *arborescens* are the accepted names (Chakrabarty & Balakrishnan 2018; WFO 2023).

The present study aimed to resolve the taxonomic identity of certain members of the genus *Glochidion* based on their morphology. The principal component analysis (PCA) and cluster analysis were carried out to authenticate the morphological evaluation of the taxa studied. All the relevant ethnobotanical information about the *Glochidion* taxa collected from Assam was documented based on primary sources that could yield potential information in the field of medical research.

MATERIALS AND METHODS

Sample collection, Identification, and Ethnobotanical assessment

Field surveys were conducted in the diverse forest areas in Assam from December 2019 to January 2023. Before conducting the field survey, approval was taken from Assam State Biodiversity Board (ASBB) and PCCF Wildlife Warden, Panjabari, Assam. *Glochidion* specimens were collected randomly from various locations in Assam, India (Table 1). During the field, collected specimens were taken in an airtight poly bag for further morphological examination and photographs of the specimens were taken using a Realme XT 64 MP mobile camera phone. Garmin GPS etrex 10 was used to record and identify precise latitudes and longitudes of the area of the specimen. In the lab, both vegetative and reproductive characteristics of freshly collected specimens were examined carefully under a Biocraft 20X simple microscope and a Leica EZ4W stereo microscope.

After a critical analysis of the character, identification was made with the help of some authentic literature (Hooker 1890; Kanjilal et al. 1940; Borthakur et al. 2018; Chakrabarty & Balakrishnan 2018), online taxonomic databases (e-Floras 2008; The Plant List 2013; GBIF

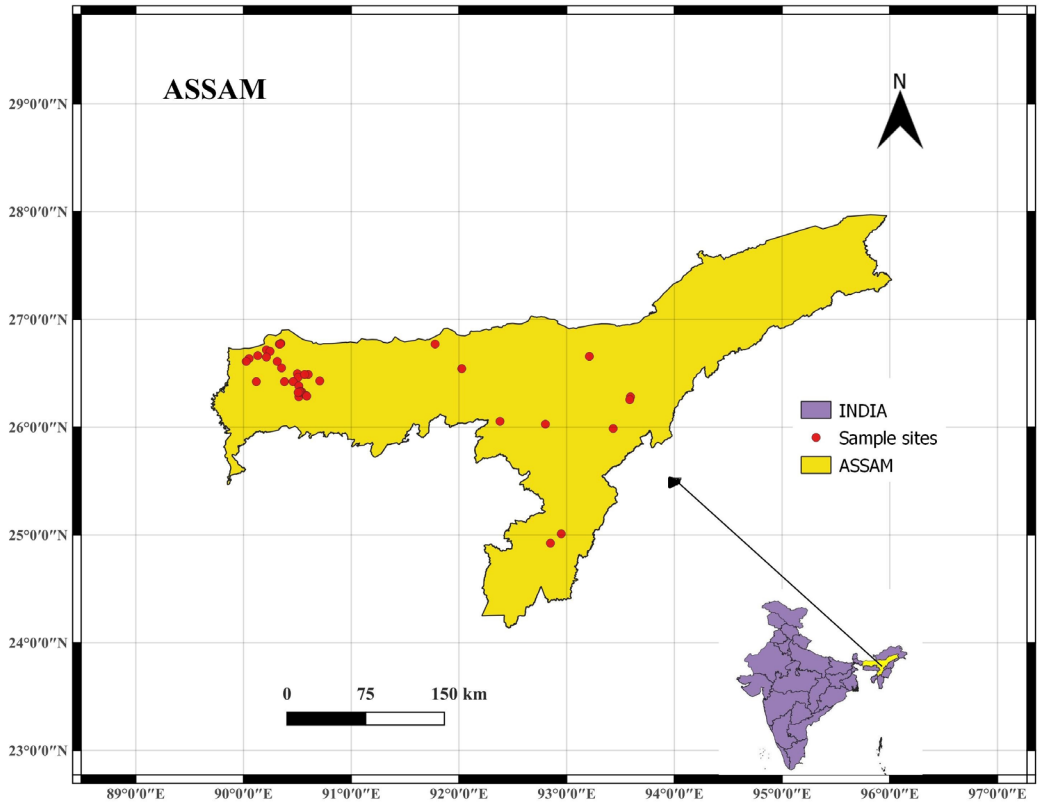

Figure 1. Distribution map of collected taxa from different places in Assam.

2021; POWO 2023) and also with the help of India herbaria (ASSAM, ARUN, and CAL) and digital herbaria (A, MO, NY) (acronyms following Thiers 2018). After reviewing pertinent literature, the threat status of the collected plant taxa was also determined (IUCN 2022). During identification, accepted scientific names and the synonyms of the collected taxa were also checked and confirmed through online databases such as IPNI, POWO, and The WFO Plant List (IPNI 2023; POWO 2023; WFO 2023). The dominant characters that played a key role in the identification of the specimen were their reproductive characters. The list of the collected specimens with their locality, accession number, GPS coordinates, and distribution map were procured (Table 1; Figure 1). The distribution map was created with QGIS 3.26.3 version software.

Ethnobotanical information of all collected taxa was made by the scrutiny of literature as well as communication with some local people and traditional healers in the study area. In addition to documenting the traditional uses and parts utilized for the specimen, we recorded their vernacular names, mode of preparation, application, and route of administration, as outlined in Table 5.

Herbarium preparation and deposition

Herbarium preparations adhered to the established techniques outlined by Jain & Rao (1977), while poisoning procedures followed the methods specified by Clark (1986). Authenticated and verified herbarium specimens for each collected taxon were deposited at the Botanical Survey of India (BSI) in Shillong, Meghalaya.

PCA and Cluster analysis

Fifteen morphological characters (Table 3) were analyzed based on using principal component analysis (PCA) and cluster analysis (Hammer et al. 2001). Multivariate PCA and hierarchical cluster analysis were assessed using the software PAST 4.06b version.

RESULTS

***Glochidion*: Morphological diagnosis**

Monoecious and rarely dioecious; primarily of shrubs or trees; pubescent or glabrous; droopingly branched. Leaves simple, alternate, usually asymmetrical at the base, entire, petiolate, stipulate. The inflorescence is usually axillary, supra-axillary, or pedunculate, with few to many flowers. Staminate flowers are mostly long

Table 1. List of recorded taxa in the studied area with their locality, accession number, and GPS coordinates.

Taxa	Locality	Accession No.	GPS coordinates
Glochidion ellipticum Wight	Kokrajhar District, Assam	98605	26.4947°N, 90.4319°E
G. heyneanum (Wight & Arn.) Wight	Kokrajhar District, Assam	98606	26.6236°N, 90.4061°E
G. lanceolarium (Roxb.) Voigt	Chakrashila Wildlife sanctuary, Kokrajhar District, Assam	98608	26.4236°N, 90.4963°E
G. multiloculare (Rottler ex Willd.) Voigt	Kokrajhar District, Assam	98604	26.7338°N, 90.4308°E
G. multiloculare var. *pubescens* Chakrab. & M.Gangop.	Orang National Park, Udalguri District, Assam	98610	26.7858°N, 92.3305°E
G. sphaerogynum (Mull.Arg.) Kurz	Chakrashila Wildlife Sanctuary, Kokrajhar District, Assam	98609	26.2902°N, 90.3747°E
G. zeylanicum var. *arborescens* (Blume) Chakrab. & M.Gangop.	Ultapani Forest Range, Kokrajhar District, Assam	98603	26.8002°N, 90.3466°E
G. zeylanicum var. *tomentosum* Trimen.	Ultapani Forest Range, Kokrajhar District, Assam	98607	26.7722°N, 90.4158°E
G. zeylanicum (Gaertn.) A.Juss	Nokpakghat, Karbi Anglong District, Assam	98611	26.3838°N, 93.2061°E

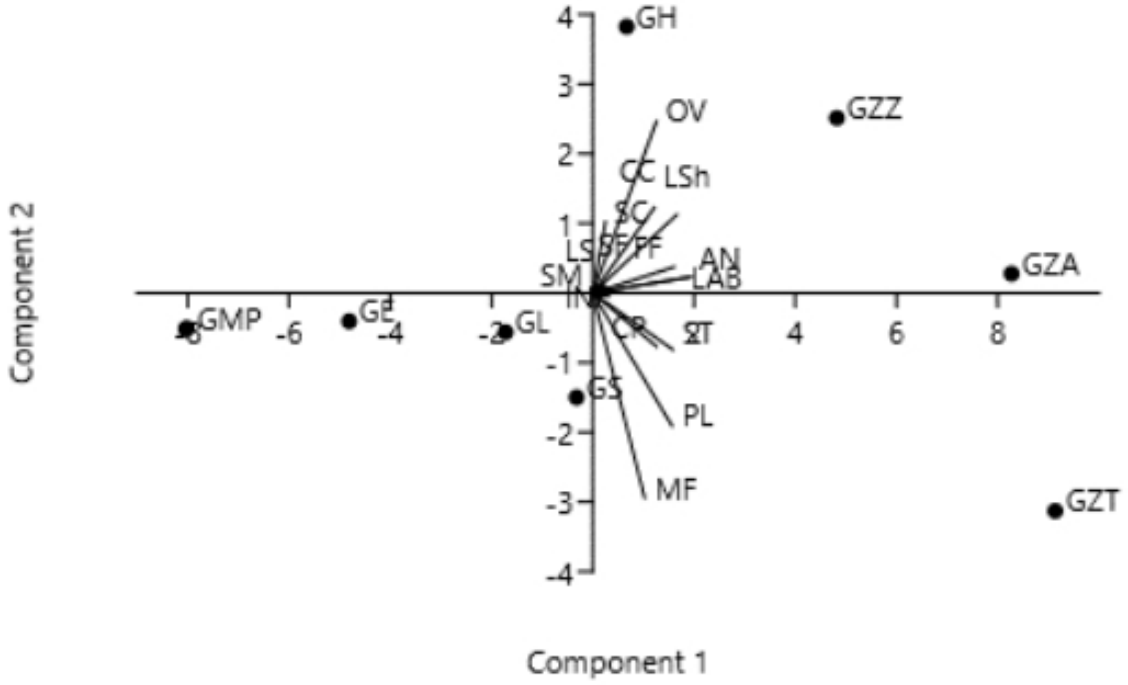

Figure 2. Multivariate Principal Component Analysis (PCA) of different members of *Glochidion* based on morphological characteristics.

pedicellate, with sepals 3–6, free, but no petals or disc. Anthers are present, 3–12, connective, pistillode absent. Pistillate flowers shortly pedicellate or sessile; sepals 3–6, free to connate; petals or disc absent; staminodes absent. Ovary 3–14 locular, biovulate locules; styles usually connate into a column, conical, or globose. Capsular pedicellate or sessile with a style column at the apex, depressed, subglobose, unlobed, and deeply or conspicuously lobed; pubescent or glabrous, green, white, or creamy to reddish. Seeds are usually 3–14, compressed, hemispherical with an arillate coat.

Review on the ethnobotanical knowledge of members of *Glochidion* in India

Some ethnobotanical uses of members of the genus *Glochidion* were mentioned by earlier workers. These are given below-

The paste of *Glochidion tomentosum* Dalz. is used externally in wounds by the tribes of Eastern Ghat, India (Reddy et al. 2006). The Chiru tribe of Manipur, India, consumed young leaves of *G. multiloculare* (Rottler ex. Willd.) Voigt and cooked them as an enjoyable curry and used them against stomach disorders (Rajkumari et

Table 2. Comparative morphological characters of certain species of genus *Glochidion* collected from different localities of Assam.

Characters	*G. ellipticum*	*G. heyneanum*	*G. lanceolarium*	*G. multiloculare* var. *multiloculare*	*G. multiloculare* var. *pubescens*	*G. sphaerogynum*	*G. zeylanicum* var. *arborescens*	*G. zeylanicum* var. *tomentosum*	*G. zeylanicum* var. *zeylanicum*
Leaf shape	Elliptic to lanceolate, oblong to obovate	Ovate to elliptic, obovate	Lanceolate to oblanceolate, elliptic	Oblong to lanceolate, elliptic to oblanceolate	Oblong to lanceolate, elliptic to oblanceolate	Oblong to elliptic, falcate	Ovate to elliptic	Ovate to elliptic, cordate	Ovate to elliptic, cordate
Leaf apex & and base	Apiculate, caudate, acuminate at apex, obtuse at base	Acute, apiculate at apex, obtuse or rounded at base	Apiculate, acuminate, or acute at apex, obtuse or rounded at base	Acute, apiculate, or retuse at apex, obtuse or rounded at base	Acute, apiculate, or retuse at apex, obtuse or rounded at base	Acuminate at apex, attenuate at base	Acute, acuminate at apex, obtuse or rounded at base	Obcordate, acute at apex, obtuse, truncate, asymmetric at base	Acute, apiculate at apex, cordate, asymmetric, truncate at base
Leaf surface	Glabrous on both surfaces	Pubescent on both surfaces and densely pubescent beneath	Glabrous on both surfaces	Glabrous on both surfaces at mature and pubescent at young	Pubescent on both surfaces and densely pubescent beneath	Glabrous on both surfaces	Densely pubescent on both surfaces	Densely pubescent on both surfaces	Glabrous on both surfaces
Petiole length	0.4–1 cm long	0.1–0.5 cm long	0.6–1 cm long	0.1–0.5 cm long	0.1–0.5 cm long	0.9–1 cm long	0.3–0.5 cm long	0.5–0.7 cm long	0.1–0.8 cm long
Inflorescence	Axillary	Axillary	Axillary	Axillary	Axillary	Axillary	Supra-axillary, pedunculate, rarely axillary	Supra-axillary, pedunculate, rarely axillary	Supra-axillary, pedunculate, rarely axillary
Male flower	Pedicellate, 0.5–1.7 cm long	Pedicellate, 0.5–1 cm long	Pedicillate, 0.9–2 cm long	Pedicellate, 0.5–1 cm long	Pedicellate, 0.5–1 cm long	Pedicellate, 0.5–1.8 cm long	Pedicellate, 0.5–0.7 cm long	Pedicellate, 0.7–1.8 cm long	Pedicellate, 0.5–1 cm long
Sepal	6	6	6	6	6	6	6	6	6
Anther	4–5	3–4	4–6	5–12	5–12	3–5	5–7	5–8	3–8
Female flower	Pedicellate, 0.1–0.5 cm long	Pedicellate, 0.1–0.6 cm long	Sessile, 0.06–0.09 cm long	Pedicellate, 0.3–0.5 cm long	Pedicellate, 0.3–0.5 cm long	Pedicellate, 0.3–0.5 cm long	Pedicellate, 0.4–0.6 cm long	Pedicellate, 0.4–1 cm long	Pedicellate, 0.1–0.9 cm long
Sepal	6	6	6	6–12	6–12	6	6	6	6
Style	Columnar, conical	Columnar	Columnar	Conical, subglobose	Conical, subglobose	Discoid	Columnar, persistent	Columnar, subconical	Free
Ovary	Subglobose, 3–6 locular	Depressed, subglobose, 4–5 locular	Depressed, subglobose, 5–8 locular	Depressed, 5-12 locular	Depressed, 5-12 locular	Depressed, 4–12 locular	Subglobose, 4–6 locular	Depressed, Subglobose, 5–8 locular	Depressed, Subglobose, 4–8 locular
Capsule	Pubescent, pedicellate, shallowly lobed	Pubescent, pedicellate, conspicuously lobed	Sparsely pubescent, sessile, shallowly lobed to deeply lobed	Pubescent, pedicellate, conspicuously lobed	Pubescent, pedicellate, conspicuously lobed	Glabrous, pedicellate, ambiguously lobed	Densely pubescent, pedicellate, obviously unlobed	Densely pubescent, pedicellate, ambiguously lobed	Glabrous, pedicellate, ambiguously lobed
Capsule color	Light green to creamy, whitish	Green to yellow-green	Light green, creamy to reddish	Green	Green	Green	Light green, yellow green to reddish	Light green, yellow green to reddish	Light green, yellow green to reddish
Seed color	Yellow green to red	Yellow green to orange	Yellow green to red	Green to red	Green to red	Green to orange	Yellow green to red	Yellow green to red	Yellow green to red

Table 3. Character state of morphological characteristics of different members of *Glochidion* used in cluster analysis.

Taxa	LSh	LAB	LS	PL	INF	MF	SM	AN	FF	SF	ST	OV	CP	CC	SC
E	1	1	2	1	0	1	0	1	1	1	1	1	1	1	1
H	4	4	1	0	0	0	0	4	3	1	2	4	2	3	3
L	2	2	2	2	0	2	0	2	2	1	2	2	2	2	1
M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MP	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S	3	3	2	3	0	3	0	3	0	1	3	3	3	0	2
ZA	6	6	1	5	1	4	0	6	5	1	5	6	4	4	1
ZT	5	7	1	6	1	5	0	7	6	1	6	2	5	4	1
ZZ	5	5	2	4	1	0	0	5	4	1	4	5	3	4	1

E—*G. ellipticum* | H—*G. heyneanum* | L—*G. lanceolarium* | M—*G. multiloculare* var. *multiloculare* | MP—*G. multiloculare* var. *pubescens* | S—*G. sphaerogynum* | ZA—*G. zeylanicum* var. *arborescens* | ZT—*G. zeylanicum* var. *tomentosum* | ZZ—*G. zeylanicum* var. *zeylanicum* | LSh—Leaf shape | LAB—Leaf apex & base | LS—Leaf surface | PL—Petiole length | INF— Inflorescense | MF—Male flower | SM—Sepal of male flower | AN—Anther | FF—Female flower | SF—Sepal of female flower | ST—Style | OV—Ovary | CP—Capsule | CC—Capsule color | SC—Seed color

Character states: Leaf Shape: Oblong to lanceolate, elliptic to oblanceolate = 0; Elliptic to lanceolate, oblong to obovate = 1; Lanceolate to oblanceolate, elliptic = 2; Oblong to elliptic, falcate = 3; Ovate to elliptic, obovate = 4; Ovate to elliptic, cordate = 5; Ovate to elliptic = 6; **Leaf apex & base:** Acute, apiculate or retuse at apex, obtuse or rounded at base = 0; Apiculate, caudate, acuminate at apex, obtuse at base = 1; Apiculate, acuminate or acute at apex, obtuse or rounded at base = 2; Acuminate at apex, attenuate at base = 3; Acute, apiculate at apex, obtuse or rounded at base = 4; Acute, apiculate at apex, cordate, asymmetric, truncate at base = 5; Acute, acuminate at apex, obtuse or rounded at base = 6; Obcordate, acute at apex, obtuse, truncate, asymmetric at base = 7; **Leaf surface:** Glabrous on both surfaces at mature and pubescent at young = 0; Pubescent on both surfaces and densely pubescent beneath = 1; Glabrous on both surfaces = 2; **Petiole length:** 0.1–0.5 cm long = 0; 0.4–1 cm long = 1; 0.6–1 cm long = 2; 0.9–1 cm long = 3; 0.1–0.8 cm long = 4; 0.3–0.5 cm long = 5; 0.5–0.7 cm long = 6; **Inflorescence:** Axillary = 0; Supra-axillary, pedunculate, rarely axillary = 1; **Male flower:** Pedicellate, 0.5–1 cm long = 0; Pedicellate, 0.5–1.7 cm long = 1; Pedicillate, 0.9–2 cm long = 2; Pedicellate, 0.5–1.8 cm long = 3; Pedicellate, 0.5–0.7 cm long = 4; Pedicellate, 0.7–1.8 cm long = 5; **Sepal of male flower:** 6 = 0; **Anther:** 5–12 = 0; 4–5 = 1; 4–6 = 2; 3–5 = 3; 3–4 = 4; 3–8 = 5; 5–7 = 6; 5–8 = 7; **Female flower:** Pedicellate, 0.3–0.5 cm long = 0; Pedicellate, 0.1–0.5 cm long = 1; Sessile, 0.06–0.09 cm long = 2; Pedicellate, 0.1–0.6 cm long = 3; Pedicellate, 0.1–0.9 cm long = 4; Pedicellate, 0.4–0.6 cm long = 5; Pedicellate, 0.4–1 cm long = 6; **Sepal of female flower:** 6–12 = 0; 6 = 1; **Style:** Conical, subglobose = 0; Columnar, conical =1; Columnar = 2; Discoid = 3; Free = 4; Columnar, persistent = 5; Columnar, subconical = 6; **Ovary:** Depressed, 5–12 locular = 0; Subglobose, 3–6 locular = 1; Depressed, subglobose, 5–8 locular = 2; Depressed, 4–12 locular = 3; Depressed, subglobose, 4–5 locular = 4; Depressed, Subglobose, 4–8 locular = 5; Subglobose, 4–6 locular = 6; **Capsule:** Pubescent, pedicellate, conspicuously lobed = 0; Pubescent, pedicellate, shallowly lobed = 1; Sparsely pubescent, sessile, shallowly lobed to deeply lobed = 2; Glabrous, pedicellate, ambiguously lobed =3; Densely pubescent, pedicellate, obviously unlobed =4; Densely pubescent, pedicellate, ambiguously lobed; **Capsule color:** Green = 0; Light green to creamy, whitish = 1; Light green, creamy to reddish = 2; Green to yellow green = 3; Light green, yellow green to reddish = 4; **Seed color:** Green to red = 0; Yellow green to red = 1; Green to orange = 2; Yellow green to orange = 3

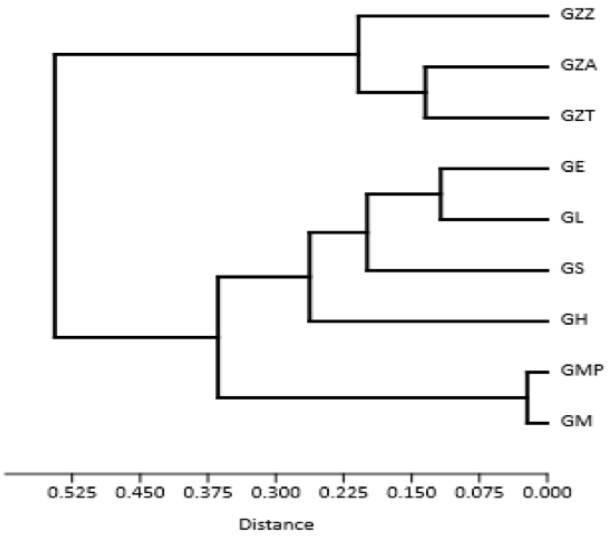

Figure 3. Paired group (UPGMA) dendrogram using hierarchical cluster analysis of different members of genus *Glochidion* based on their morphological characteristics.

Table 4. Principal component analysis (PCA) based on morphological characteristics of different members of *Glochidion*.

PC	Eigenvalue	% variance
1	41.3263	83.254
2	4.25921	8.5804
3	2.02297	4.0754

al. 2013). The bark of *G. multiloculare* is used for skin diseases and wounds (Bajpai et al. 2016). Roots of *G. multiloculare* are used in snake bites (Brahma et al. 2002). The fruit and stem of *G. heyneanum* (Wight & Arn.) Wight is used in diabetes, fever, and bone fracture (Kumar et al. 2019). Roots of *G. heyneanum* are used in snake bites (Bajpai et al. 2016). Barks and leaves of *G. zeylanicum* (Gaertn.) A.Juss. are used in snake bites and stomach ulcers, and tender shoots are applied to itches (Das et al. 2013; Chakrabarty & Balakrishnan 2018; Kumar et al. 2019). Branches and leaves of *G. sphaerogynum* (Mull. Arg.) Kurz. are used in influenza and eczema (Lalrinkimi & Lallianthanga 2019). Fruits of *G. daltonii* (Mull.Arg.) Kurz. is used in cough and dysentery, and the bark of *G. ellipticum* Wight is used in inflammation (Bajpai et al.

Table 5. Enumeration of ethnobotanical knowledge of *Glochidion* in Assam.

Botanical name	Vernacular names	Parts used	Mode of preparation	Application	Route of administration
Glochidion multiloculare (Rottler ex Willd.) Voigt	Thakha Biphang or thakha mala (Bodo), Gorumora, Dolpoduli (Assamese)	Leaves, barks, Roots	- A small number of leaves are ground into a paste. - A small amount of bark is taken and ground into a paste. - 3–4 roots are taken to make a paste.	- Fracture and body swelling - Skin diseases and wounds - Snake bite	- External - External - External
G. ellipticum Wight	Thakha Biphang or thakha mala (Bodo), Panimadhuri (Assamese), Latimaowa (Nepali)	Bark, stem branches, and roots	- A small amount of bark is removed and ground into a paste, which is then administered to the diseased area. - A paste is made by crushing the stem and applying it to the swelling area. - Roots are ground into a paste.	- Body swelling, Skin problem - Body swelling - Snake bite	- External - External - External
G. sphaerogynum (Mull.Arg.) Kurz.	Thakha Biphang or thakha mala (Bodo), Panimadhuri (Assamese), Boljakru (Garo)	Young branches and leaves	Young branches and leaves are ground into a paste and blended with a small amount of water.	- Skin diseases - Branches are used as firewood also.	- External

2016). The paste made from the seeds of *G. ellipticum* is used as an antiallergic (Babu 1995). The bark of *G. lanceolarium* (Roxb.) Voigt is used in stomach diseases and is used as an anti-itch drug, oil made from seeds is also used as a source of light (Chanda et al. 2007; Bajpai et al. 2016; Chakrabarty & Balakrishnan 2018). The seeds of *G. calocarpum* Kuna are applied externally for skin diseases, and leaves are used orally to cure fever (Elanchezhian et al. 2007). According to Lalfakzuala et al. (2007), fruits of *G. arborescens* are used as wild edible fruits that are consumed by the local people of Mizoram. The fruits of *G. khasicum* (Mull.Arg.) Hook.f. are also edible and consumed by the tribal people of the Khasi hills in Meghalaya (Chakrabarty & Balakrishnan 2018).

DISCUSSION

The comparative morphological characteristics of certain species of the genus *Glochidion* showed many similarities and distinctive characteristics, which can be helpful for the identification and classification of the taxa (Table 2). Some of the major distinctive characteristics were leaf morphology, petiole length, and reproductive structures, i.e., inflorescences, male and female flowers, anthers, style, ovary, and capsule. The presence or absence of hairs on stems, leaves, inflorescence, and capsules also significantly differentiates the taxa. *G. multiloculare* var. *pubescens* an endemic variety of Assam showed nearly identical habit, vegetative and reproductive characteristics, with the exception of a glabrous plant body in *G. multiloculare* var. *multiloculare* (Chakrabarty & Balakrishnan 2018). The other major distinctive characteristics of both the taxa are that solitary or individual flowers and fruits occur in each axil in *G. multiloculare* var. *pubescens* while multiple flowers and fruits in each axil of the plant body have been observed in *G. multiloculare* var. *multiloculare*. The variety *G. zeylanicum* var. *tomentosum* presented almost the same character as *G. zeylanicum* var. *zeylanicum*, with the major difference being its hairy or tomentose character. *G. heyneanum* showed puberulous habits on the stems and leaves. In some taxa, leaves were asymmetric or symmetric at the base.

The majority of taxa exhibited axillary inflorescence while *G. zeylanicum* var. *zeylanicum, G. zeylanicum* var. *tomentosum* and *G. zeylanicum* var. *arborescens* showed supra-axillary or pedunculate and rarely axillary inflorescence. Male flowers of the taxa revealed remarkably similar traits, but the number of anthers separated them. Female flowers presented different characteristics from male flowers. The peduncles of all the female flowers were shorter than the male flowers. The number of locules in the ovary varied by taxon, and style characters also played a key role. The shape, size, color, locules, and hairy habit of the capsule were distinguished among taxa, which showed taxonomic significance. Some taxa like *G. zeylanicum* var. *zeylanicum* and their varieties, were easily identified with their unlobed and ambiguously lobed capsule. *G. multiloculare* and *G. sphaerogynum* exhibited deeply or conspicuously lobed capsules while *G. ellipticum* presented a superficially lobed capsule. The capsule of *G. lanceolarium* was sessile, i.e., the fruit without the stalk or it lacked a pedicel, which distinguished it from other taxa. When dried, most of the leaves of the members were curled at the margin. While *Glochidion* and *Epicephala* moths were mutualists (Kato et al.

2003), most *Glochidion* leaves and drooping branches were found in insect-damaging conditions. As a result, some easily detectable characters for taxa identification could exist.

Based on morphological data, both PCA and cluster analysis were analyzed (Table 3–4 & Figure 2–3). The first PCA variance was 83.254% with an eigenvalue of 41.3263 followed by the second PCA variance of 8.5804% with an eigenvalue of 4.25921. The line connected to PC1 and PC2 makes up 91.8344% of the total variance and is a good sign of the variability of the initial data. PC1 represented the variation of the taxa based on the characters such as leaf shape (LSh), leaf apex and base (LAB), anther (AN), female flower (FF), sepal of the female flower (SF), ovary (OV), capsule color (CC), seed color (SC) and PC2 represented the characters such as leaf surface (LS), petiole length (PL), inflorescence (INF), male flower (MF), sepal of male flower (SM), style (ST), capsule (CP). In PC1, five taxa were observed i.e., *G. ellipticum* (GE), *G. lanceolarium* (GL), *G. multiloculare* var. *pubescens* (GMP), *G. sphaerogynum* (GS), and *G. zeylanicum* var. *tomentosum* (GZT). PC2 denoted a total of four taxa, viz., *G. heyneanum* (GH), *G. multiloculare* var. *multiloculare* (GM), *G. zeylanicum* var. *arborescens* (GZA), and *G. zeylanicum* var. *zeylanicum* (GZZ). From cluster analysis the tree revealed that *G. multiloculare* var. *multiloculare* (GM) and *G. multiloculare* var. *pubescens* (GMP) as cluster 1, *G. heyneanum* (GH) as cluster 2, *G. sphaerogynum* (GS) as cluster 3, *G. ellipticum* (GE) and *G. lanceolarium* (GL) as cluster 4, *G. zeylanicum* var. *arborescens* (GZA), and *G. zeylanicum* var. *tomentosum* (GZT) as cluster 5, *G. zeylanicum* var. *zeylanicum* (GZZ) as cluster 6. Taxa present in the same cluster specified more correlation than the taxa present in the different clusters.

The ethnobotanical study revealed that some members of the genus *Glochidion* were traditionally used to cure different diseases (Table 5) in Assam. Among the uses, the most frequent are skin diseases, fractures, body swelling, and snake bites.

CONCLUSION

The study revealed that there are similarities and differences among the members of the genus *Glochidion* which are more reliable for grouping and classifying the taxa. Documentation of ethnobotanical evidence signifies the importance of the genus. Both primary and secondary sources of the ethnobotanical knowledge showed the members have medicinally important properties and almost all parts, i.e., leaves, bark, and roots, have been used by the local people for the treatment of various diseases in India including Assam. This study summarized that both taxonomical study and conservation of ethnobotanical knowledge are of great significance, with the ability to stimulate subsequent biological investigation. Moreover, PCA and cluster analysis also validated the data on comparative morphological traits that showed correlation and variation among the analyzed species.

Key to the species and varieties based on vegetative and reproductive characters

1. Inflorescence axillary 2
1. Inflorescence axillary to supra-axillary 6

2. Capsules shortly pedicellate 3
2. Capsules sessile ..... *G. lanceolarium*

3. Leaves curl upwards with a margin when dry ..... *G. sphaerogynum*
3. Leaves do not curl upwards with a margin when dry 4

4. Plant part glabrous except the reproductive organs ..... *G. multiloculare* var. *multiloculare*
4. Plant parts all pubescent ..... *G. multiloculare* var. *pubescens*

5. Capsules 3–6 locular; green to white creamy ..... *G. ellipticum*
5. Capsules 4–5 locular; yellowish-green ..... *G. heyneanum*

6. Fruits obscurely lobed 7
6. Capsules unlobed ..... *G. zeylanicum* var. *arborescens*

7. Plants entirely glabrous ..... *G. zeylanicum* var. *zeylanicum*
7. Plant parts all pubescent ..... *G. zeylanicum* var. *tomentosum*

Image 1. Morphological characters: A—*Glochidion multiloculare* var. *multiloculare* | B—*G. ellipticum* | C—*G. heyneanum* | D—*G. lanceolarium* | E—*G. sphaerogynum* | F—*G. multiloculare* var. *pubescens* | G—*G. zeylanicum* var. *zeylanicum* | H—*G. zeylanicum* var. *arborescens* | I—*G. zeylanicum* var. *tomentosum*. © Priyanka Brahma.

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– Taimur Al Said, Haitham Al Rawahi, Maha Al Ansari, Al Mutasim Al Hinai, Ahmed Al Amri, Ahmed Al Wahaibi, Ghasi Al Farsi, Saud Al Wihibi & Salman Al Farsi, Pp. 24443–24446

First report of the longhorn beetle, *Rosalia* (*Eurybatus*) *formosa* (Saunders, 1839) (Insecta: Coleoptera: Cerambycidae) from Mizoram, India
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Publisher & Host

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Threatened Taxa

APPENDIX 2

SPECIMENS DEPOSITED IN BSI, SHILLONG (ASSAM)

भारत सरकार/GOVERNMENT OF INDIA
पर्यावरण वन एवंजलवायु परिवर्तन मंत्रालय/MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
भारतीय वनस्पति सर्वेक्षण/BOTANICAL SURVEY OF INDIA
प्रभारी वैज्ञानिक का कार्यालय/OFFICE OF THE SCIENTIST IN-CHARGE
पूर्वी क्षेत्रीय केंद्र/EASTERN REGIONAL CENTRE
शिलांग-793003/SHILLONG – 793003

दूरभाष/Telephone: 0364- 2223971, 2223618 ई-मेल/e-mail- bsibsishll@yahoo.co.in Telefax: 0364- 2224119

संख्या/No.: BSI/ERC/Tech/2022-23/ 240 दिनाक/Dated: 19.07.2022

सेवा मे/To,

Miss Priyanka Brahma
Ph.D Research Scholar
Department of Botany
Bodoland University
Kokrajhar, Assam- 783 370

विषय/Sub.: Accession of plant specimen and incorporation at ASSAM herbarium. reg.

Dear Miss Brahma,

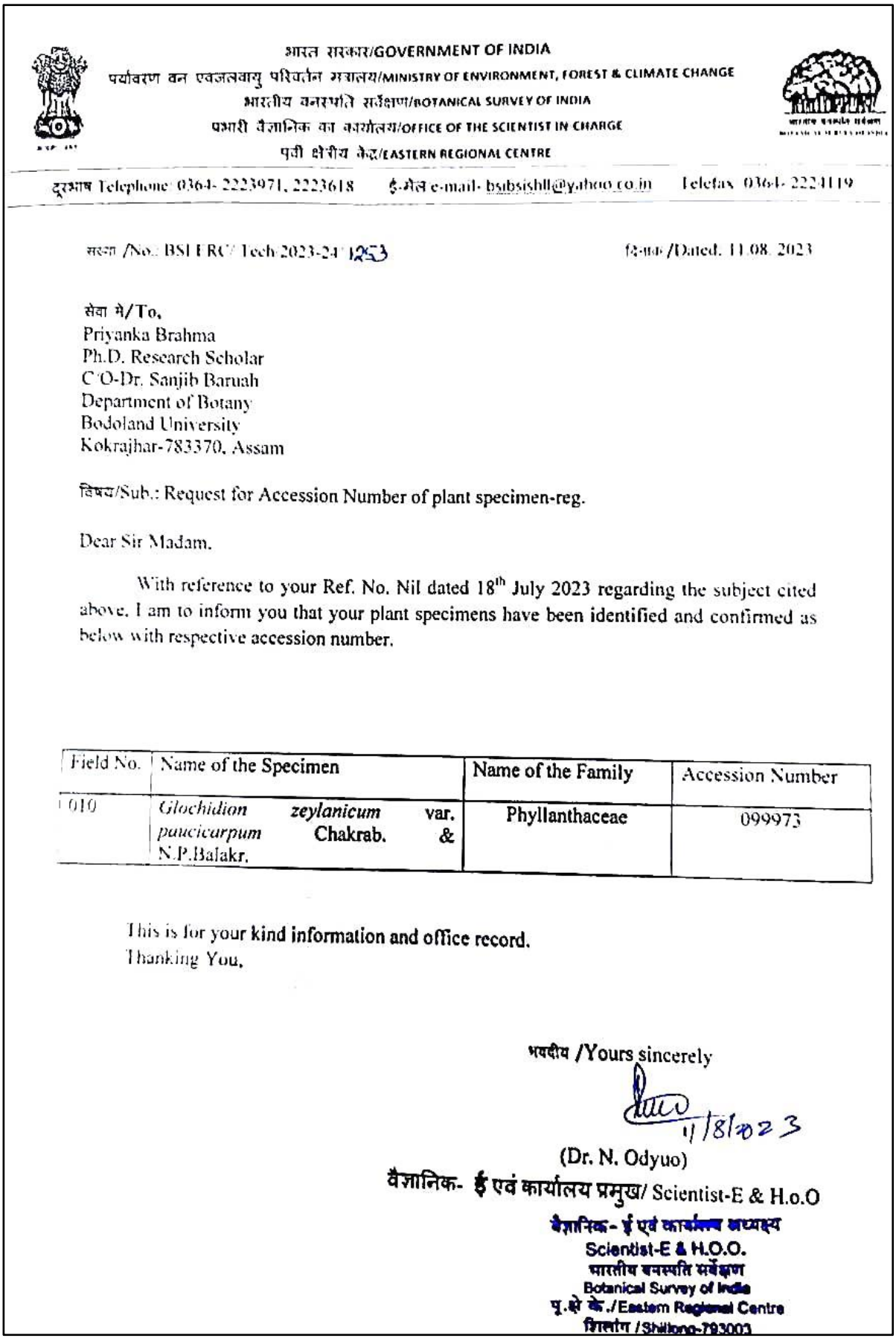
With reference to your letter No. nil, dated 06/07/2022 regarding the subject cited above, I am to inform you that your plant specimen have been incorporated in ASSAM with accession number as below.

Sl.	Coll. No.	Species	Family	Accession no.
1.	001	*Glochidion zeylanicum* var. *arborescens* (Blume) Chakrab. & M.Gangop.	Phyllanthaceae	98603
2.	002	*Glochidion multiloculare* (Rottler ex Willd.) Voigt var. *multiloculare*	Phyllanthaceae	98604
3.	003	*Glochidion ellipticum* Wight	Phyllanthaceae	98605
4.	004	*Glochidion heyneanum* (Wight & Arn.) Wight var. *heyneanum*	Phyllanthaceae	98606
5.	005	*Glochidion zeylanicum* var. *tomentosum* Trimen	Phyllanthaceae	98607
6.	006	*Glochidion zeylanicum* (Gaertn.) A.Juss. var. *zeylanicum*	Phyllanthaceae	98611
7.	007	*Glochidion lanceolarium* (Roxb.) Voigt	Phyllanthaceae	98608
8.	008	*Glochidion sphaerogynum* (Mull.Arg.) Kurz	Phyllanthaceae	98609
9.	009	*Glochidion multiloculare* var. *pubescens* Chakrab. & M.Gangop.	Phyllanthaceae	98610

This is for your kind information and necessary office record.
Thank you / सधन्यवाद

भवदीय/Yours sincerely
19/7/2022
(Dr. N. Odyuo)
वैज्ञानिक- E एवं कार्यालय प्रमुख/ Scientist-E & HoO

Figure 39. Deposited voucher specimens with accession number



भारत सरकार/GOVERNMENT OF INDIA
पर्यावरण वन एवजलवायु परिवर्तन मंत्रालय/MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
भारतीय वनस्पति सर्वेक्षण/BOTANICAL SURVEY OF INDIA
प्रभारी वैज्ञानिक का कार्यालय/OFFICE OF THE SCIENTIST IN CHARGE
पूर्वी क्षेत्रीय केंद्र/EASTERN REGIONAL CENTRE

दूरभाष Telephone 0364- 2223971, 2223618 ई-मेल e-mail- bsibsishll@yahoo.co.in Telefax 0364- 2224119

संख्या /No.: BSI ERC/ Tech/2023-24/ 1253 दिनांक /Dated. 11.08.2023

सेवा में/To,
Priyanka Brahma
Ph.D. Research Scholar
C/O-Dr. Sanjib Baruah
Department of Botany
Bodoland University
Kokrajhar-783370, Assam

विषय/Sub.: Request for Accession Number of plant specimen-reg.

Dear Sir Madam,

With reference to your Ref. No. Nil dated 18th July 2023 regarding the subject cited above, I am to inform you that your plant specimens have been identified and confirmed as below with respective accession number.

Field No.	Name of the Specimen	Name of the Family	Accession Number
010	*Glochidion zeylanicum* var. *paucicarpum* Chakrab. & N.P.Balakr.	Phyllanthaceae	099973

This is for your kind information and office record.
Thanking You,

भवदीय /Yours sincerely

11/8/2023

(Dr. N. Odyuo)
वैज्ञानिक- ई एवं कार्यालय प्रमुख/ Scientist-E & H.o.O

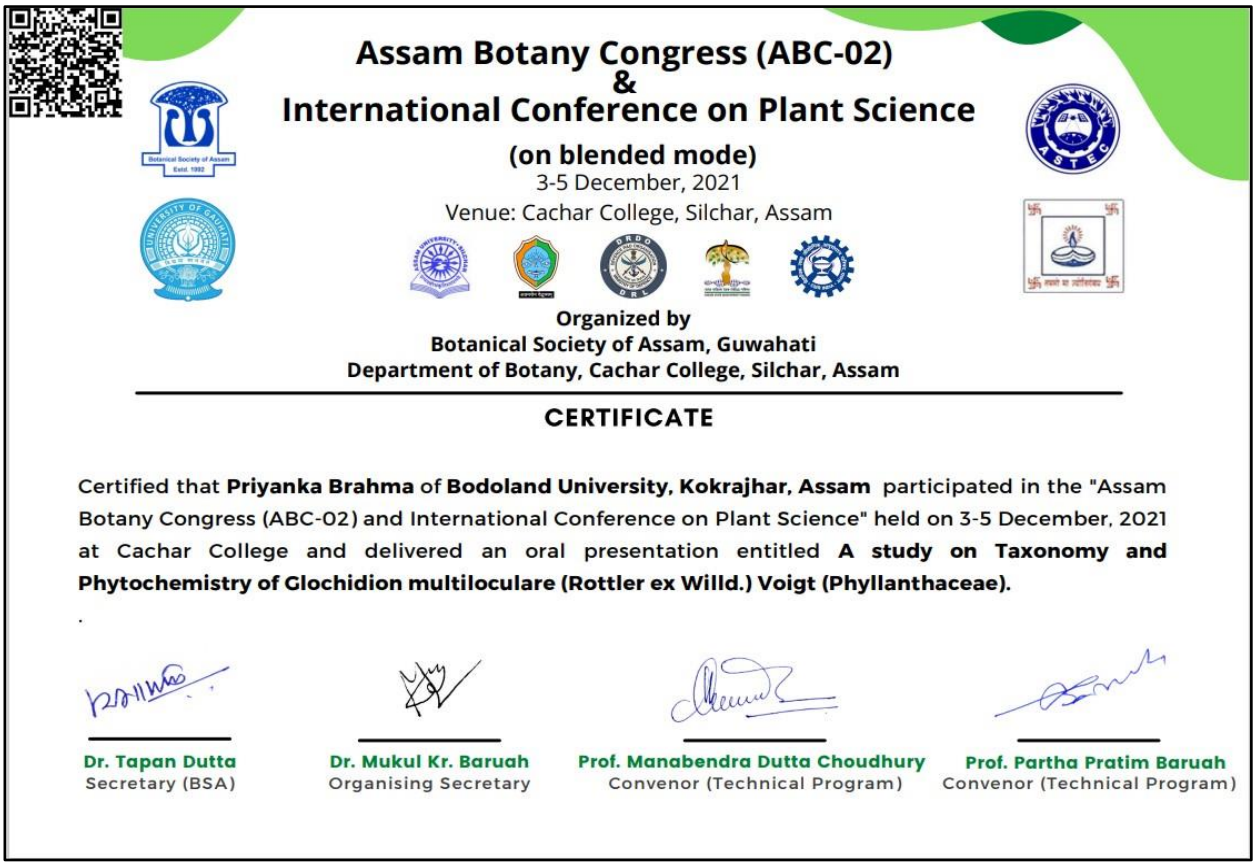
वैज्ञानिक- ई एवं कार्यालय अध्यक्ष
Scientist-E & H.O.O.
भारतीय वनस्पति सर्वेक्षण
Botanical Survey of India
पू.क्षे.के./Eastern Regional Centre
शिलांग /Shillong-793003

Figure 40. Deposited voucher specimens with accession number

APPENDIX 3

SEMINAR PRESENTATION

1. Assam Botany Congress (ABC-02) & International Conference on Plant Science organized by Botanical Society of Assam, Guwahati and Department of Botany, Cachar College, Silchar, Assam (2021) (**Figure 41**)
2. National Seminar on Ethnobotany and Resource Management of the Bodos' organized by the Centre for Bodo Studies, Bodoland University, Kokrajhar, Assam (2021) (**Figure 42**)
3. National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India & Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST) jointly organized by Department of Botany, Rajiv Gandhi University and East Himalayan Society for Spermatophyte Taxonomy, Botanical Survey of India (2022) (**Figure 43**)
4. International Seminar on Advances in Entrepreneurial Botany: Entrepreneurship Opportunities from Plant Resources for Sustainable Development organized by Department of Botany, University of Science & Technology Meghalaya in collaboration with CSIR-National Botanical Research Institute, Lucknow (2022) (**Figure 44**)
5. Bodoland International Knowledge Festival, 2023, India organized by Bodoland Territorial Region (BTR), Government & Bodoland University, Kokrajhar, Assam (2023) (**Figure 45**)
6. 2nd National Conference on Natural Products/AYUSH System of Medicine organized by Experimental Pharmacology Laboratory (EPL), Department of Pharmacology, PGIMER, Chandigarh under the aegis of Tridev Aushdiya Podh Utpadak Farmer Society, Rohal, IUPHAR-NP in collaboration with RCFC (NR-1) of National Medicinal Plant Board Ministry of AYUSH, Govt. of India, Joginder Nagar, Mandi, H.P (2024) (**Figure 46**)
7. National Seminar on Biodiversity for Sustainable Future with special focus on Plant Taxonomy and Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST) organized by Department of Botany, Gauhati University, Assam (2024) **(Figure 47)**



Assam Botany Congress (ABC-02)
&
International Conference on Plant Science

(on blended mode)
3-5 December, 2021
Venue: Cachar College, Silchar, Assam

Organized by
Botanical Society of Assam, Guwahati
Department of Botany, Cachar College, Silchar, Assam

CERTIFICATE

Certified that **Priyanka Brahma** of **Bodoland University, Kokrajhar, Assam** participated in the "Assam Botany Congress (ABC-02) and International Conference on Plant Science" held on 3-5 December, 2021 at Cachar College and delivered an oral presentation entitled **A study on Taxonomy and Phytochemistry of Glochidion multiloculare (Rottler ex Willd.) Voigt (Phyllanthaceae).**

.

Dr. Tapan Dutta
Secretary (BSA)

Dr. Mukul Kr. Baruah
Organising Secretary

Prof. Manabendra Dutta Choudhury
Convenor (Technical Program)

Prof. Partha Pratim Baruah
Convenor (Technical Program)

Figure 41. Certificate of oral presentation in Assam Botany Congress (ABC-02) & International Conference on Plant Science

Centre for Bodo Studies, Bodoland University

National Seminar on
'Ethnobotany and Resource Management of the Bodos'
(December 10, 2021)

CERTIFICATE

As Paper Presenter

This is to certify that Priyanka Brahma of Bodoland University, Assam, has presented a paper entitled Diversity and ethnobotanical knowledge of genus *Glochidion* J.R. Forst. & G. Forst. (Phyllanthaceae) in Kokrajhar district, Assam (Author(s): Priyanka Brahma, Sanjib Baruah) in the National Seminar organized by the Centre for Bodo Studies, Bodoland University held on 10th December, 2021.

B. Prahlad
Dr. Prahlad Basumatary
Director
Centre for Bodo Studies
Bodoland University

Ladusingh
Prof. Laishram Ladusingh
Vice Chancellor
Bodoland University

CENTRE FOR BODO STUDIES

CENTRE FOR BODO STUDIES, BODOLAND UNIVERSITY * ETHNOBOTANY AND RESOURCE MANAGEMENT OF BODOS * HELD ON 10TH DECEMBER, 2021 * NATIONAL SEMINAR 2021

Figure 42. Certificate of oral presentation in the National Seminar on Ethnobotany & Resource Management of the Bodos'

National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and North-East India

&

Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHHST)

Jointly organized by

DEPARTMENT OF BOTANY, RAJIV GANDHI UNIVERSITY
EAST HIMALAYAN SOCIETY FOR SPERMATOPHYTE TAXONOMY
BOTANICAL SURVEY OF INDIA

CERTIFICATE

This is to Certify that **Ms. Priyanka Brahma** of **Bodoland University, Kokrajhar, Assam** presented a paper (ORAL) entitled "*Studies on comparative morphology of certain species of Glochidion J.R.Forst. & G.Forst. (Phyllanthaceae) occuring in Assam*" in National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and Northeast India & Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST), scheduled on February 21-22, 2022.

(Dr. Tonlong Wangpan)
Organizing Secy.

(Prof. Sumpam Tangjang)
Organizing Chairman

(Prof. Saket Kushwaha)
Vice-Chancellor, RGU

Figure 43. Certificate of oral presentation in the National Seminar & Annual Conference

International Seminar on

"Advances in Entrepreneurial Botany: Entrepreneurship Opportunities from Plant Resources for Sustainable Development"

Organized by: Department of Botany

UNIVERSITY OF SCIENCE & TECHNOLOGY MEGHALAYA

Accredited 'A' Grade by NAAC

In collaboration with: CSIR-National Botanical Research Institute Lucknow

Certificate of Participation

This is to certify that Mr./Ms./Dr. Priyanka Brahma

of Department of Botany, Bodoland University, Kokrajhar (Assam) has participated in the International Seminar on **"Advances in Entrepreneurial Botany: Entrepreneurship Opportunities from Plant Resources for Sustainable Development"** Organised by Department of Botany, USTM, in Collaboration with CSIR-National Botanical Research Institute Lucknow held on 27th - 29th October, 2022 and presented a paper (Oral/Poster) entitled 'Diversity and distribution of some species of genus Glochidion J.R. Forst & G. Forst. (Phyllanthaceae) in Assam.

We wish him/her all success in life.

Prof G. D. Sharma
Vice Chancellor USTM

Dr. Mautushi Das
Convener

Prof S.K. Barik
Director, CSIR-NBRI Lucknow

Techno City, Khanapara, Kling Road, Baridua, 9th Mile, Ri-Bhoi, Meghalaya-793101
Ph. 9508 444 000/0361-2895030/098540-23060, Website : www.ustm.ac.in

Figure 44. Certificate of Oral Presentation in the International Seminar

BODOLAND INTERNATIONAL KNOWLEDGE FESTIVAL, 2023, INDIA

(27th February to 2nd March, 2023)

Bodoland Territorial Region (BTR), Government
&
Bodoland University, Kokrajhar, India

CERTIFICATE

Certified that Prof./Dr./Sri/Smt./Km. **Priyanka Brahma** of Department of Botany, Bodoland University, Kokrajhar, Assam, India awarded **3rd prize** in the Poster Presentation of the Bodoland International Knowledge Festival, 2023 held under the auspices of Bodoland University, Kokrajhar. She presented poster in the technical session, under the theme Indigenous Knowledge System (IKS).

Title of the paper: Evaluation of Indigenous Knowledge, Phytochemical Screening and GC-MS Analysis of *Glochidion multiloculare* (Rottler Ex Willd.) Voigt (Phyllanthaceae)

Mode of Presentation: Poster

Theme Coordinator
BIKF, 2023

Conference Chair
BIKF, 2023

Registrar
Bodoland University

Vice-Chancellor
Bodoland University

Figure 45. Certificate of 3rd prize of the poster presentation in BIKF, 2023, India

Figure 46. Certificate of Oral Presentation in the 2nd National Conference

NATIONAL SEMINAR ON

BIODIVERSITY FOR SUSTAINABLE FUTURE
WITH SPECIAL FOCUS ON PLANT TAXONOMY
AND ANNUAL CONFERENCE OF
EAST HIMALAYAN SOCIETY FOR SPERMATOPHYTE TAXONOMY (EHSST)

27th & 28th September, 2024
Department of Botany, Gauhati University

CERTIFICATE OF PARTICIPATION

This is to certify that, Mr./Ms./Prof./Dr. Priyanka Brahma of Dept. of Botany, Bodoland University participated in the National Seminar on Biodiversity for Sustainable Future with special focus on Plant Taxonomy as a delegate & chaired a technical session ..... / presented a paper entitled Phytochemical profiling, in vitro antioxidant activity and GC-MS analysis of Glochidion sphaerogynum (Mull. Arg.) Kurz

Prof. A.K. Pandey
President
EHSST

Prof. P.P. Baruah
Convener
Organizing Committee

Prof. N. Devi
President
Organizing Committee

Dr. N. Nath
Organizing Secretary
Organizing Committee

Figure 47. Certificate of Oral Presentation in the National Seminar and Annual Conference

APPENDIX 4

WORKSHOP AND TRAINING

1. One-Day Workshop on Research Manuscript Writing and Publication in Reputed Journal organized by the Centre for Bodo Studies, Bodoland University, Kokrajhar, Assam (2021) (**Figure 48**)
2. Two Days National Workshop (Online) on Plant Identification and Herbarium Methodology jointly organized by Botanical Survey of India, Central National herbarium, Howrah and Bareilly College, Bareilly (U.P.) NSS Unit-I (Boys) (2021) (**Figure 49**)
3. One day Hands-on training on Plants Identification and Documentation organized by the Department of Botany, Bodoland University, Kokrajhar, Assam (2021) (**Figure 50**)
4. Two days National workshop on Green Biotechnology and Therapeutic Potential of Medicinal Plants jointly organized by Department of Botany and Zoology, S. S. Khanna Girl's Degree, Prayagraj (2022) (**Figure 51**)
5. Hands-on Workshop on Advanced Techniques in Natural Products & Medicinal Chemistry organized by CSIR-Indian Institute of Integrative Medicine, Jammu (2022) (**Figure 52**)
6. Awareness workshop on Access & Benefit Sharing (ABS) and Peoples' Biodiversity Register jointly organized by Assam State Biodiversity Board, Guwahati and Department of Zoology, Bodoland University, Kokrajhar, Assam (2022) (**Figure 53**)
7. Training Course on Classical & Modern Methods in Plant Taxonomy & Biosystematics organized by CSIR-National Botanical Research Institute, Lucknow (2024) (**Figure 54**)

Certificate No. CBS/19 Date. 23/10/21

बर' फरायसं मिरु

CENTRE FOR BODO STUDIES

Bodoland University, Kokrajhar

CERTIFICATE

This is to certify that Prof./Dr./Mr./Ms. Priyanka Brahma
Working as Research Scholar, B.U has participated in the one-day workshop on **RESEARCH MANUSCRIPT WRITING AND PUBLICATION IN REPUTED JOURNAL** held on 7th October, 2021, organised by the Centre for Bodo Studies, Bodoland University

Vice-Chancellor
Bodoland University

Director
Centre for Bodo Studies, BU

Figure 48. Certificate of Worksop on Research manuscript writing

TWO DAYS NATIONAL WORKSHOP (ONLINE) ON
PLANT IDENTIFICATION AND HERBARIUM METHODOLOGY

Jointly Oraganized By

Botanical Survey Of India, Central National Herbarium, Howrah
and
Bareilly College, Bareilly (U.P.) NSS Unit-I (Boys)

On 29th October And 01st November 2021

Certificate of Participation

Presented to

Priyanka Brahma

for his/her active participation in the event.

Dr. R.K. Gupta
Head, CNH
BSI, Howrah

Dr. Rajeev Kumar Yadav
Organizing Secretary
Asstt. Professor (Botany)
P.O. NSS
Bareilly College, Bareilly (U.P.)

Dr. Nisha Verma
Convenor
Asstt. Professor (Botany)
VRAL Govt. Girls Degree College, Bareilly (U.P.)

Made for free with Certify'em

Figure 49. Certificate of Workshop on Plant Identification & Herbarium Methodology

Figure 50. Certificate of Hands-on training on Plant Identification & Documentation

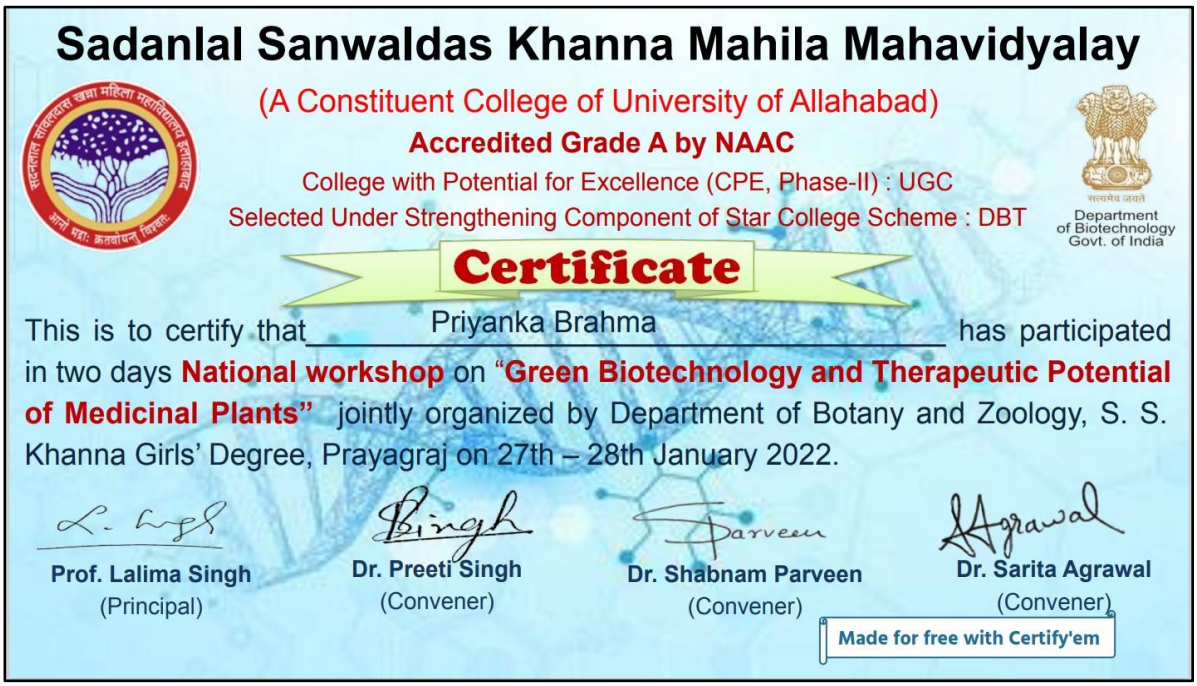


Figure 51. Certificate of Workshop on Green Biotechnology and Therapeutic Potential of Medicinal Plants

Figure 52. Certificate of High- End Workshop (KARYASHALA)

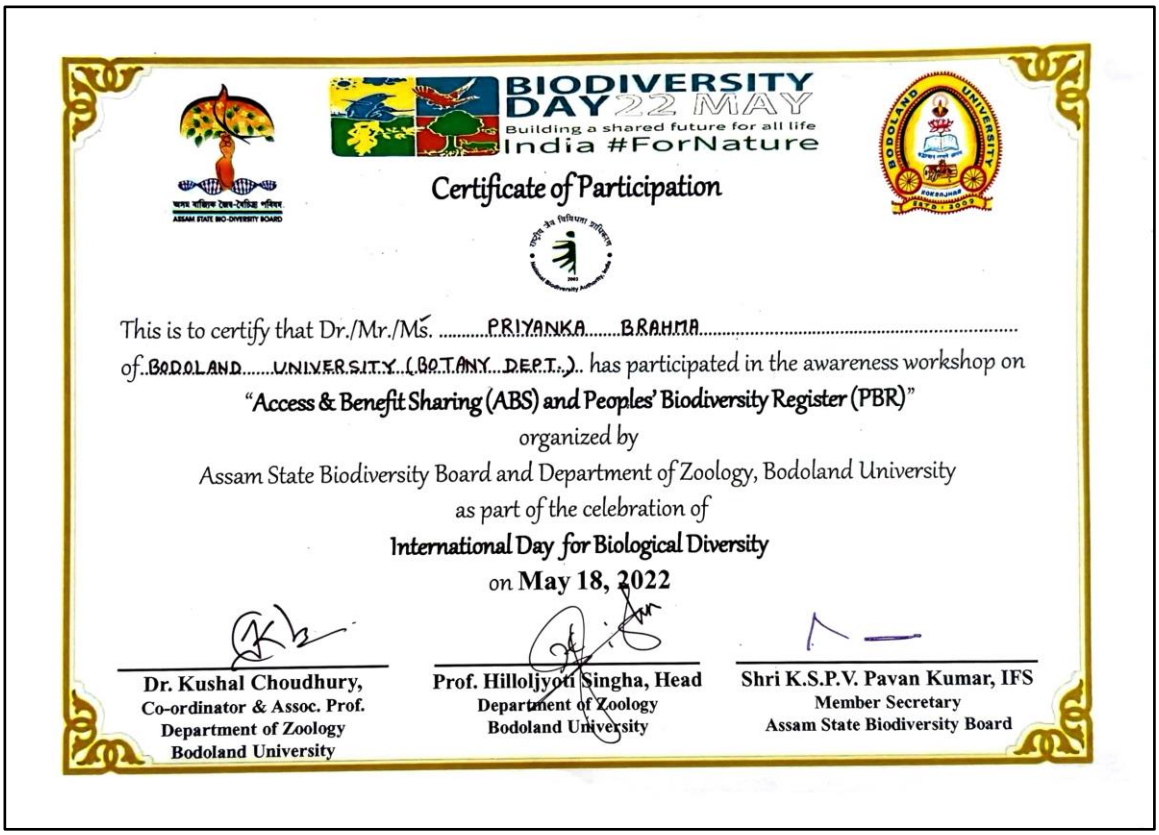


Figure 53. Certificate of Workshop on ABS & PBR

वै.औ.अ.प. - राष्ट्रीय वनस्पति अनुसंधान संस्थान, लखनऊ
CSIR-National Botanical Research Institute, Lucknow
Training Course on
Classical & Modern Methods in Plant Taxonomy & Biosystematics

Certificate

This is to certify that
Mr./Ms./Dr. Priyanka Brahma
of Bodoland University, Kokrajhar, Assam
participated and successfully completed the training course on
"Classical & Modern Methods in Plant Taxonomy and Biosystematics"
organized by CSIR-National Botanical Research Institute, Lucknow
during 21-27 February, 2024.

Dr. Vijay V Wagh
Course Coordinator

Dr. Sanjeeva Nayaka
Convener

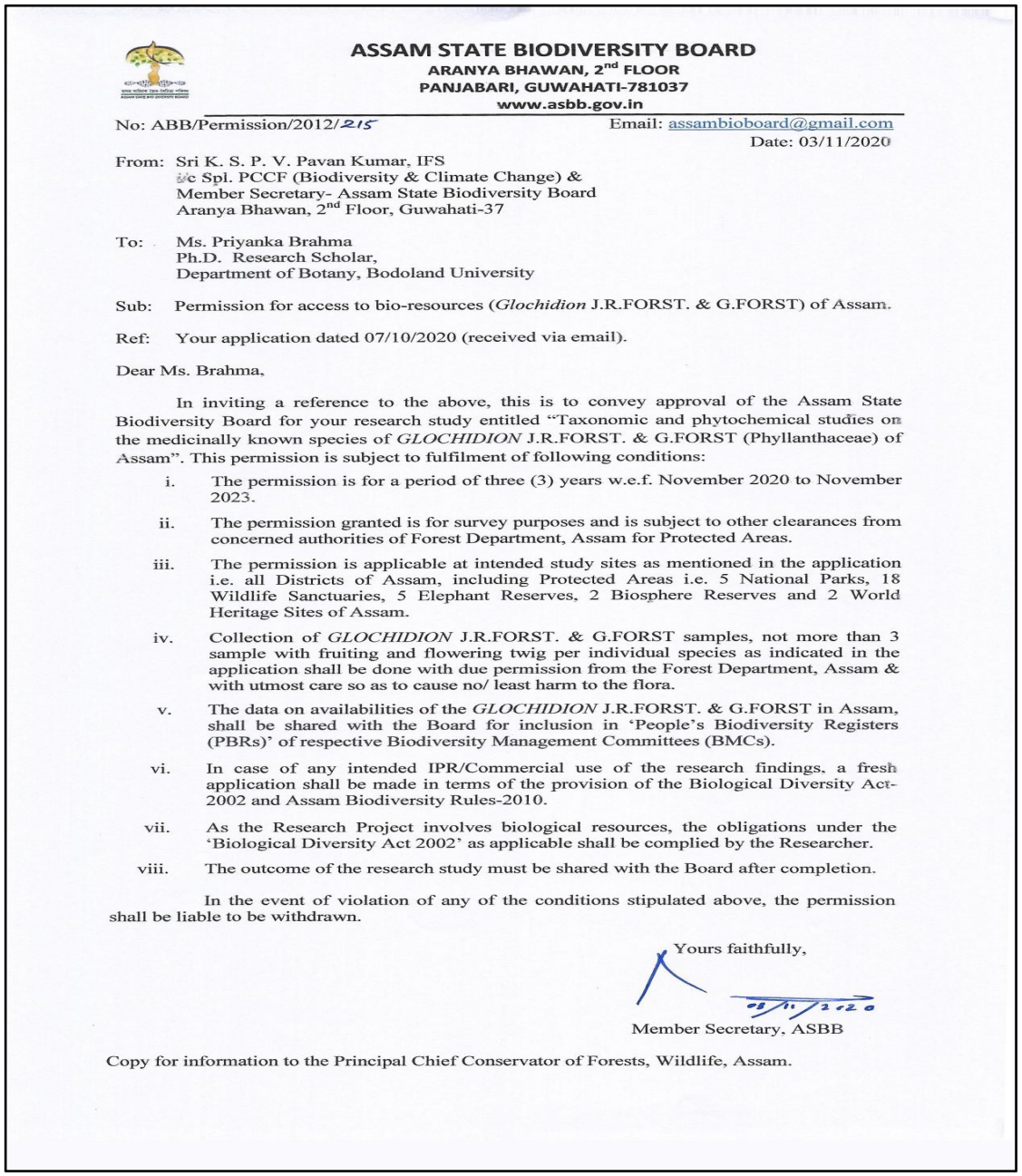
Dr. Ajit Kumar Shasany
Director, CSIR-NBRI

Figure 54. Certificate of Training Course on Classical & Modern Methods in Plant Taxonomy & Biosystematics

APPENDIX 5

PERMISSION

For field surveys and collection of the specimens in different protected areas of Assam permission was taken from the Assam State Biodiversity Board (ASBB) and Principal Chief Conservator of Forests (PCCF), Chief Wildlife Warden, Panjabari, Guwahati, Assam (**Figure 55 to Figure 58**).



ASSAM STATE BIODIVERSITY BOARD
ARANYA BHAWAN, 2nd FLOOR
PANJABARI, GUWAHATI-781037
www.asbb.gov.in

No: ABB/Permission/2012/215 Email: assambioboard@gmail.com
Date: 03/11/2020

From: Sri K. S. P. V. Pavan Kumar, IFS
i/c Spl. PCCF (Biodiversity & Climate Change) &
Member Secretary- Assam State Biodiversity Board
Aranya Bhawan, 2nd Floor, Guwahati-37

To: Ms. Priyanka Brahma
Ph.D. Research Scholar,
Department of Botany, Bodoland University

Sub: Permission for access to bio-resources (*Glochidion* J.R.FORST. & G.FORST) of Assam.

Ref: Your application dated 07/10/2020 (received via email).

Dear Ms. Brahma,

In inviting a reference to the above, this is to convey approval of the Assam State Biodiversity Board for your research study entitled "Taxonomic and phytochemical studies on the medicinally known species of *GLOCHIDION* J.R.FORST. & G.FORST (Phyllanthaceae) of Assam". This permission is subject to fulfilment of following conditions:

i. The permission is for a period of three (3) years w.e.f. November 2020 to November 2023.

ii. The permission granted is for survey purposes and is subject to other clearances from concerned authorities of Forest Department, Assam for Protected Areas.

iii. The permission is applicable at intended study sites as mentioned in the application i.e. all Districts of Assam, including Protected Areas i.e. 5 National Parks, 18 Wildlife Sanctuaries, 5 Elephant Reserves, 2 Biosphere Reserves and 2 World Heritage Sites of Assam.

iv. Collection of *GLOCHIDION* J.R.FORST. & G.FORST samples, not more than 3 sample with fruiting and flowering twig per individual species as indicated in the application shall be done with due permission from the Forest Department, Assam & with utmost care so as to cause no/ least harm to the flora.

v. The data on availabilities of the *GLOCHIDION* J.R.FORST. & G.FORST in Assam, shall be shared with the Board for inclusion in 'People's Biodiversity Registers (PBRs)' of respective Biodiversity Management Committees (BMCs).

vi. In case of any intended IPR/Commercial use of the research findings, a fresh application shall be made in terms of the provision of the Biological Diversity Act-2002 and Assam Biodiversity Rules-2010.

vii. As the Research Project involves biological resources, the obligations under the 'Biological Diversity Act 2002' as applicable shall be complied by the Researcher.

viii. The outcome of the research study must be shared with the Board after completion.

In the event of violation of any of the conditions stipulated above, the permission shall be liable to be withdrawn.

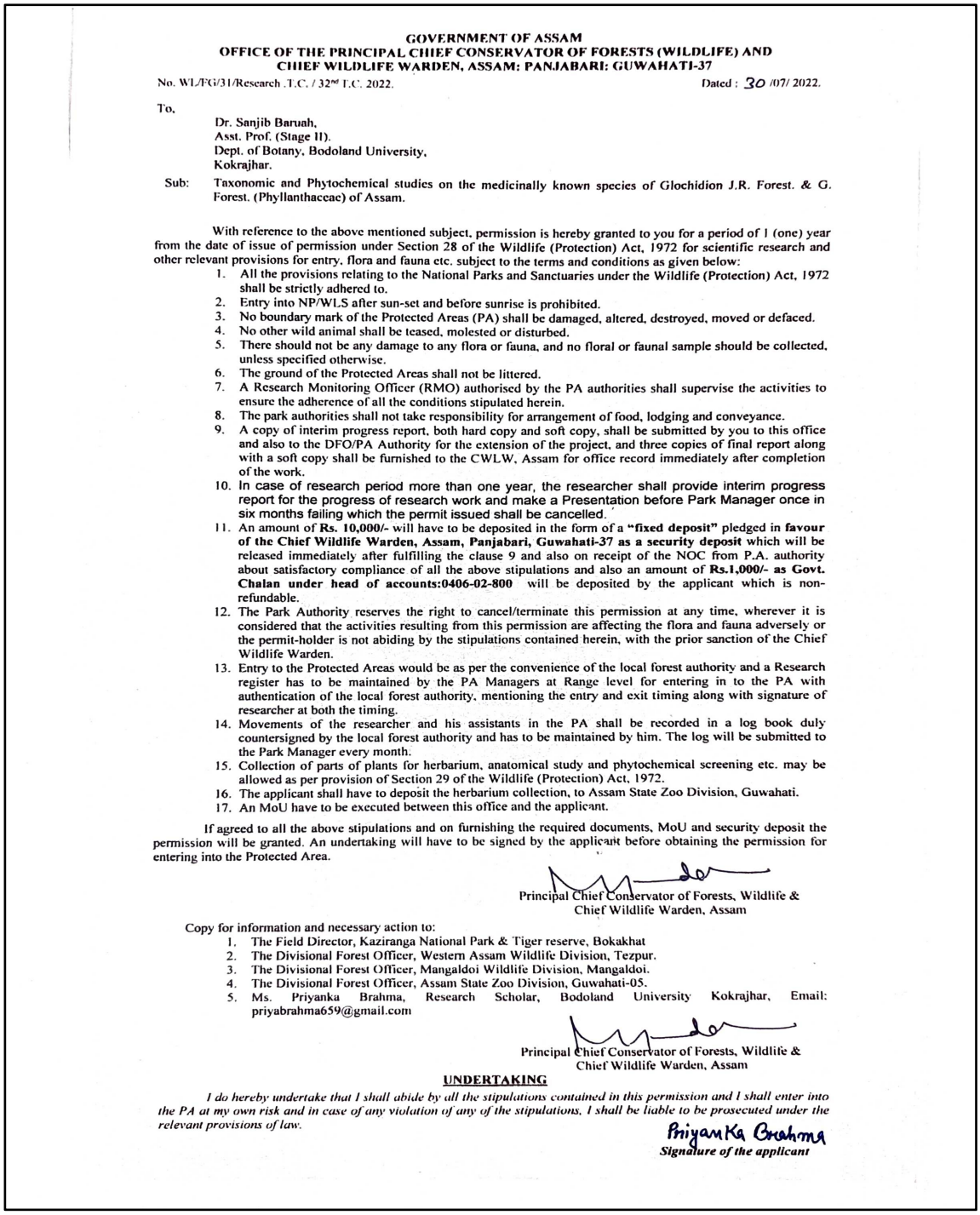
Yours faithfully,

03/11/2020

Member Secretary, ASBB

Copy for information to the Principal Chief Conservator of Forests, Wildlife, Assam.

Figure 55. Permission copy from ASBB



GOVERNMENT OF ASSAM
OFFICE OF THE PRINCIPAL CHIEF CONSERVATOR OF FORESTS (WILDLIFE) AND CHIEF WILDLIFE WARDEN, ASSAM: PANJABARI: GUWAHATI-37

No. WL/FG/31/Research .T.C. / 32nd T.C. 2022. Dated : 30 /07/ 2022.

To,

Dr. Sanjib Baruah,
Asst. Prof. (Stage II).
Dept. of Botany, Bodoland University,
Kokrajhar.

Sub: Taxonomic and Phytochemical studies on the medicinally known species of Glochidion J.R. Forest. & G. Forest. (Phyllanthaceae) of Assam.

With reference to the above mentioned subject, permission is hereby granted to you for a period of 1 (one) year from the date of issue of permission under Section 28 of the Wildlife (Protection) Act, 1972 for scientific research and other relevant provisions for entry, flora and fauna etc. subject to the terms and conditions as given below:

1. All the provisions relating to the National Parks and Sanctuaries under the Wildlife (Protection) Act, 1972 shall be strictly adhered to.
2. Entry into NP/WLS after sun-set and before sunrise is prohibited.
3. No boundary mark of the Protected Areas (PA) shall be damaged, altered, destroyed, moved or defaced.
4. No other wild animal shall be teased, molested or disturbed.
5. There should not be any damage to any flora or fauna, and no floral or faunal sample should be collected, unless specified otherwise.
6. The ground of the Protected Areas shall not be littered.
7. A Research Monitoring Officer (RMO) authorised by the PA authorities shall supervise the activities to ensure the adherence of all the conditions stipulated herein.
8. The park authorities shall not take responsibility for arrangement of food, lodging and conveyance.
9. A copy of interim progress report, both hard copy and soft copy, shall be submitted by you to this office and also to the DFO/PA Authority for the extension of the project, and three copies of final report along with a soft copy shall be furnished to the CWLW, Assam for office record immediately after completion of the work.
10. In case of research period more than one year, the researcher shall provide interim progress report for the progress of research work and make a Presentation before Park Manager once in six months failing which the permit issued shall be cancelled.
11. An amount of **Rs. 10,000/-** will have to be deposited in the form of a **"fixed deposit"** pledged in **favour of the Chief Wildlife Warden, Assam, Panjabari, Guwahati-37 as a security deposit** which will be released immediately after fulfilling the clause 9 and also on receipt of the NOC from P.A. authority about satisfactory compliance of all the above stipulations and also an amount of **Rs.1,000/- as Govt. Chalan under head of accounts:0406-02-800** will be deposited by the applicant which is non-refundable.
12. The Park Authority reserves the right to cancel/terminate this permission at any time, wherever it is considered that the activities resulting from this permission are affecting the flora and fauna adversely or the permit-holder is not abiding by the stipulations contained herein, with the prior sanction of the Chief Wildlife Warden.
13. Entry to the Protected Areas would be as per the convenience of the local forest authority and a Research register has to be maintained by the PA Managers at Range level for entering in to the PA with authentication of the local forest authority, mentioning the entry and exit timing along with signature of researcher at both the timing.
14. Movements of the researcher and his assistants in the PA shall be recorded in a log book duly countersigned by the local forest authority and has to be maintained by him. The log will be submitted to the Park Manager every month.
15. Collection of parts of plants for herbarium, anatomical study and phytochemical screening etc. may be allowed as per provision of Section 29 of the Wildlife (Protection) Act, 1972.
16. The applicant shall have to deposit the herbarium collection, to Assam State Zoo Division, Guwahati.
17. An MoU have to be executed between this office and the applicant.

If agreed to all the above stipulations and on furnishing the required documents, MoU and security deposit the permission will be granted. An undertaking will have to be signed by the applicant before obtaining the permission for entering into the Protected Area.

Principal Chief Conservator of Forests, Wildlife &
Chief Wildlife Warden, Assam

Copy for information and necessary action to:

1. The Field Director, Kaziranga National Park & Tiger reserve, Bokakhat
2. The Divisional Forest Officer, Western Assam Wildlife Division, Tezpur.
3. The Divisional Forest Officer, Mangaldoi Wildlife Division, Mangaldoi.
4. The Divisional Forest Officer, Assam State Zoo Division, Guwahati-05.
5. Ms. Priyanka Brahma, Research Scholar, Bodoland University Kokrajhar, Email: priyabrahma659@gmail.com

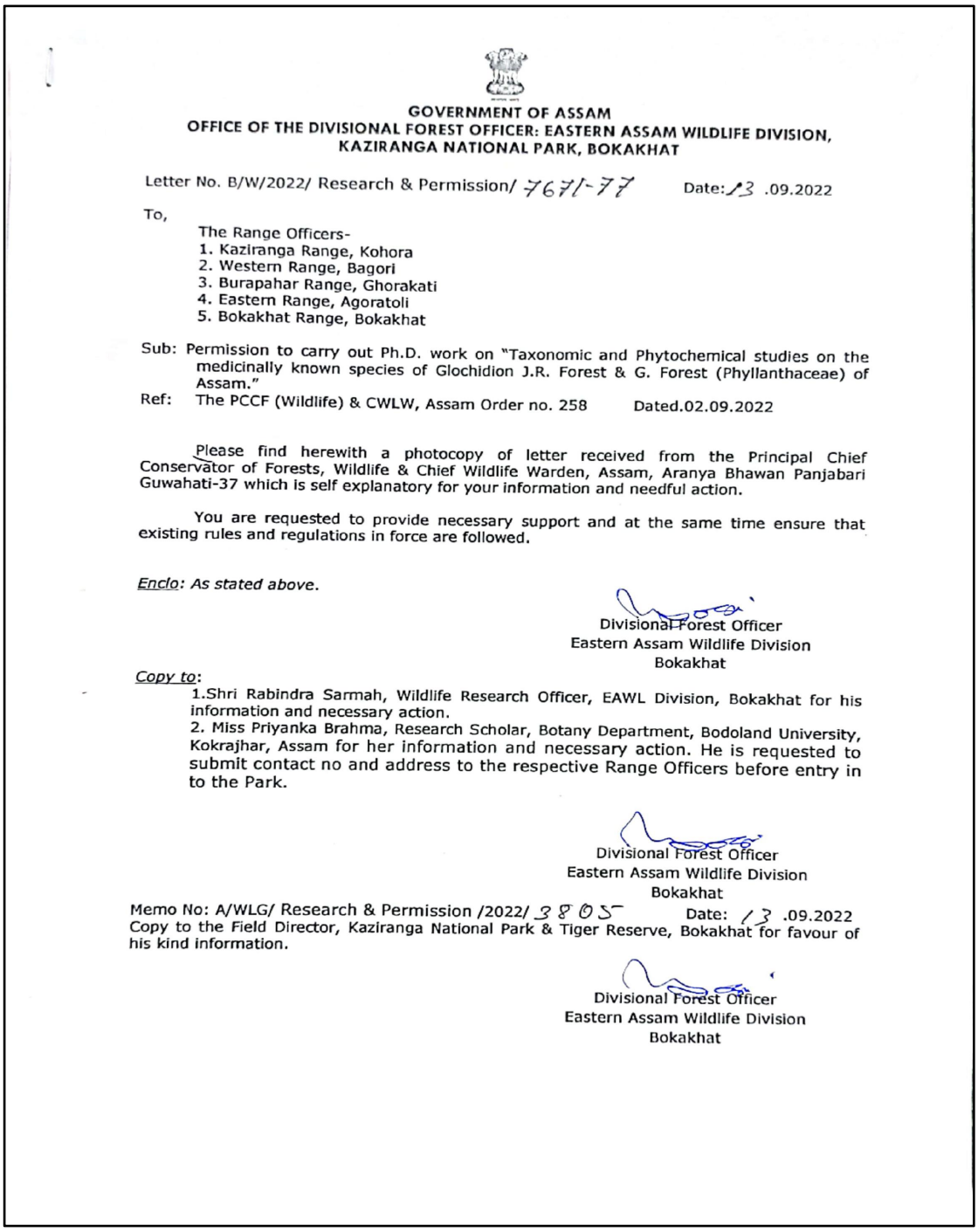
Principal Chief Conservator of Forests, Wildlife &
Chief Wildlife Warden, Assam

UNDERTAKING

I do hereby undertake that I shall abide by all the stipulations contained in this permission and I shall enter into the PA at my own risk and in case of any violation of any of the stipulations, I shall be liable to be prosecuted under the relevant provisions of law.

Priyanka Brahma
Signature of the applicant

Figure 56. Permission copy from PCCF



GOVERNMENT OF ASSAM
OFFICE OF THE DIVISIONAL FOREST OFFICER: EASTERN ASSAM WILDLIFE DIVISION,
KAZIRANGA NATIONAL PARK, BOKAKHAT

Letter No. B/W/2022/ Research & Permission/ 7671-77 Date: 13 .09.2022

To,

The Range Officers-
1. Kaziranga Range, Kohora
2. Western Range, Bagori
3. Burapahar Range, Ghorakati
4. Eastern Range, Agoratoli
5. Bokakhat Range, Bokakhat

Sub: Permission to carry out Ph.D. work on "Taxonomic and Phytochemical studies on the medicinally known species of Glochidion J.R. Forest & G. Forest (Phyllanthaceae) of Assam."

Ref: The PCCF (Wildlife) & CWLW, Assam Order no. 258 Dated.02.09.2022

Please find herewith a photocopy of letter received from the Principal Chief Conservator of Forests, Wildlife & Chief Wildlife Warden, Assam, Aranya Bhawan Panjabari Guwahati-37 which is self explanatory for your information and needful action.

You are requested to provide necessary support and at the same time ensure that existing rules and regulations in force are followed.

Enclo: As stated above.

Divisional Forest Officer
Eastern Assam Wildlife Division
Bokakhat

Copy to:

1.Shri Rabindra Sarmah, Wildlife Research Officer, EAWL Division, Bokakhat for his information and necessary action.
2. Miss Priyanka Brahma, Research Scholar, Botany Department, Bodoland University, Kokrajhar, Assam for her information and necessary action. He is requested to submit contact no and address to the respective Range Officers before entry in to the Park.

Divisional Forest Officer
Eastern Assam Wildlife Division
Bokakhat

Memo No: A/WLG/ Research & Permission /2022/ 3805 Date: 13 .09.2022
Copy to the Field Director, Kaziranga National Park & Tiger Reserve, Bokakhat for favour of his kind information.

Divisional Forest Officer
Eastern Assam Wildlife Division
Bokakhat

Figure 57. Permission copy from PCCF

GOVERNMENT OF ASSAM
OFFICE OF THE PRINCIPAL CHIEF CONSERVATOR OF FORESTS, WILDLIFE & CHIEF WILDLIFE WARDEN, ASSAM, ARANYA BHAWAN:::PANJABARI:::GUWAHATI-37.
Email ID: cwlw.assam@gmail.com

Office Order No. 258 Dated Guwahati the . 02 / 09 /2022.

The Permission to carry out Ph.D. work on "Taxonomic and Phytochemical studies on the medicinally known species of Glochidion J.R. Forest. & G. Forest. (Phyllanthaceae) of Assam" to be conducted in Kaziranga National Park, Orang National Park, Nameri National Park and Borail Wildlife Sanctuary in Assam is hereby accorded to Miss. Priyanka Brahma, Research Scholar, Botany Department, Bodoland University, Kokrajhar, Assam for a period of one year from the date of issue of the order under Section 28 of the Wildlife (Protection) Act, 1972 (as amended up to date) on submission of the undertaking to abide by all the stipulations laid down as communicated vide this office letter No. WL/FG/31/Research .T.C/32nd T.C.2022, dtd. 30/07/2022. The petitioner deposited an amount of Rs. 10,000/-(Rupees Ten Thousand) only as security deposit vide Account No. 5276166545, dated 17/08/2022, Central Bank of India, Kokrajhar, Assam, India pledged in favour of the Chief Wildlife Warden, Assam which is refundable and also deposited a non-refundable amount of Rs. 1000/- (Rupees One Thousand) vide Treasury Challan No.22/08/1611, dated 17/08/2022, SBI Bank, Kokrajhar only as revenue. The permission may be extended for the period as requested in the initial application subject to submission of progress report to this office.

(M.K. Yadava, IFS)
Chief Wildlife Warden, Assam

Memo No. WL/FG/31/Research .T.C/32nd T.C.2022 Dated Guwahati the. 02 /09 /2022.

Copy for information and necessary action to:-

1. The Field Director, Kaziranga National Park & Tiger Reserve, Bokakhat.
2. The Divisional Forest Officer, Western Assam Wildlife Division, Tezpur.
3. The Divisional Forest Officer, Mangaldoi Wildlife Division, Mangaldoi.
4. The Divisional Forest Officer, Assam State Zoo Division, Guwahati.
5. Dr. Sanjib Baruah, Asst. Prof. (Stage II), Department of Botany, Bodoland University, Korajhar.
6. Miss. Priyanka Brahma, Research Scholar, Department of Botany, Bodoland University Korajhar, Email: priyabrahma659@gmail.com
7. Office Order Book.

Chief Wildlife Warden, Assam

Figure 58. Permission copy from PCCF